

# CHEMICAL & METALLURGICAL ENGINEERING

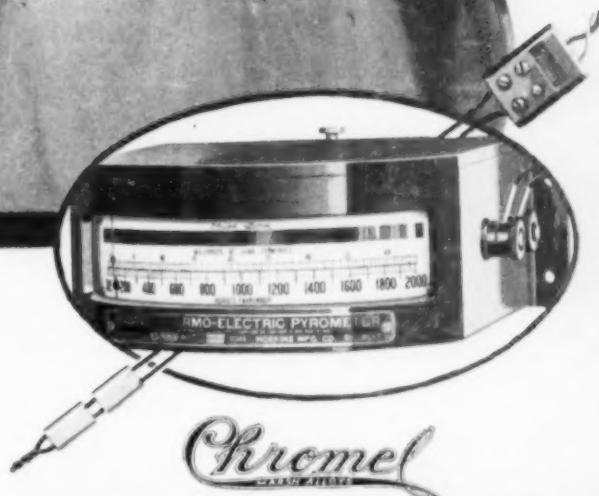


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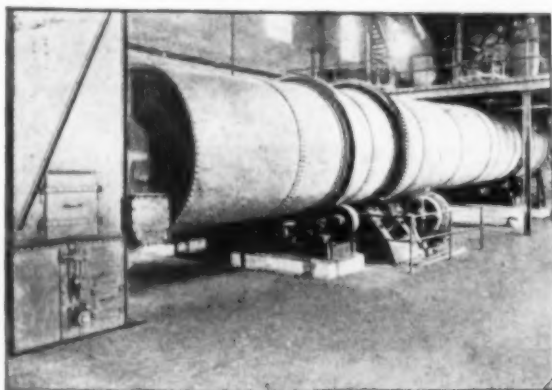
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# CHEMICAL & METALLURGICAL ENGINEERING

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## The Goose Or the Egg

**A**BANDONMENT or curtailment of research by certain industrial laboratories is reported or rumored frequently of late. The psychology of the times, both present and recent past, partly explains this; but it is by no means a justification of the tendency. It is simply another instance of killing the goose which lays the golden egg.

During the war period we had a most wonderful demonstration of the effectiveness of industrial research. Many industries profited beyond their wildest dreams from technical investigations then undertaken for the first time. One would think that these at least would have been thoroughly "sold on the idea." It appears, however, that even some such organizations feel that they now know enough to do without further research.

Perhaps one of the most serious causes of research curtailment has been the fact that many inadequately trained, inexperienced chemists have gone into this field and undertaken to do work which was beyond their capabilities.

A generation ago we spoke of a man as a scientist and the term had a definite meaning. A decade ago the term "chemist" was of rather specific significance; today, however, it is necessary to qualify very materially the term "chemist" before one can really comprehend clearly the field to which such professional worker is suited. We not only need to specify whether it be in organic, inorganic, physical or electro chemistry or other similar field, but also we must specify whether it be in so-called "pure" research, industrial research, plant control or other application of the specialized branch of chemistry that the experience and fitness of the worker lies. It is perhaps desirable, certainly inevitable, that those poorly qualified for industrial research organizations should be eliminated at an early date. However, it is to be hoped that a mad campaign of economy will not cut off what should be in the long run one of the most profitable branches of the industry—namely, the research division.

In consideration of a research organization, the industrial executive should understand that it is not at all like other departments which within a short time can be expected to show profit, with discontinuance or reorganization as a penalty for failure. Research requires extended periods of preliminary work, often apparently unprofitable. A great many trials must be made which give only negative results. Often the executive fails to realize that these negative results may be more valuable in avoiding errors of plant design or operation than positive constructive conclusions. In the end, however, well organized, properly directed research will pay.

There is no industry which we need to except when making this statement.

We have ample demonstration in large corporate laboratories, such as that of the General Electric Company, that intelligently managed "big business" knows the profit of a research organization working on fundamental problems which sooner or later will be of advantage to the industry. In another branch of electrical operations the tungsten filament lamp is found a product of pure research. This did not come about early in the work; it was rather the outgrowth of long investigation which at many stages was doubtless discouraging. Other industries will have similar experiences and other industries, if they will but be conservative in their urgent demands upon research, will correspondingly profit.

Let us keep the goose alive even if it does mean that we must go and draw a bit from our savings account in order to buy cracked corn and ground bone (or whatever food it is that this kind of a goose may need) in order that we may hope for our golden eggs.

## Increasing Output By Preventing Disease

**I**F THE average business man were to read in his morning paper tomorrow that there had just been discovered 1,000,000 cases of smallpox in the United States, he probably would close up his factory or office and move his family to seclusion in the country and develop a state of panicky interest characteristic of our American people. On the other hand, he reads the statement that there are 1,000,000 cases of tuberculosis in the United States today and it does not excite him a bit. Why? Smallpox is a fatal, quickly developing, acute disease; tuberculosis is a chronic, slowly developing, long-drawn-out malady. And yet the economic loss as well as the loss in other ways from tuberculosis is vastly greater in one year than the loss from smallpox for two centuries.

Consider for a moment what 1,000,000 sick consumptives implies as it relates to industry. While accurate figures are not available, it is a conservative estimate that at least 800,000 of the million are workingmen and workingwomen. Probably the percentage is higher. If everyone of them lost on an average only fifty cents a day in production to themselves and their employers, the total daily loss would be \$400,000. That this is a conservative figure any employer of large groups of men will agree. A sick man, whether he is in bed or whether he is at his bench as a producer, costs money to himself, to his employer and to his community.

Take the situation in some of the metal trades for example. Ten per cent more foundrymen and molders die of tuberculosis between the ages of twenty-five and



forty-four than do men generally in the same age periods. This means that in the years of greatest productivity more men die in this industry of tuberculosis than in other groups. Of workers exposed to metallic dust in general, of which there are many thousands between the ages of twenty-five and forty-four, 5 per cent more die of tuberculosis than among workmen in general and 10 per cent more than among farmers, to contrast them with one of the particularly favored groups. Again, 21 per cent of the deaths in this large group are caused by tuberculosis; or to take a more specific group, among iron and steel workers 16.9 per cent of all deaths are caused by tuberculosis.

Investigations by FREDERICK L. HOFFMAN in this country and by Sir THOMAS OLIVER in England and by many others in various parts of the world have clearly shown that constant exposure of workmen to metallic dust and to chemical fumes leads to increased tuberculosis.

The reason for this is not far to seek. Tuberculosis is caused by a germ that usually enters the body in early childhood. Most men carry the germs of tuberculosis hidden away in their bodies before they reach the age of twenty-one. Whenever the tissues of the lungs or other tissues of the body become weakened by disease, self-indulgence or by the constant irritation of some substance such as fine metal dust particles or gassy fumes, the soil is prepared and the latent, already-present germ begins to develop an active process and under these favorable conditions the disease known as tuberculosis definitely sets in.

The problem of tuberculosis in industry, therefore, resolves itself into these two definite phases: First, the prevention of infection. This involves safeguards against spitting, sneezing and coughing by providing proper receptacles, by constant education, by periodic medical examination and otherwise. Second, by building up and maintaining resistance to the highest notch of efficiency. This requires not only constant medical supervision and continuous education but the development of the best community activities for recreation. It implies also that the workman shall have not only proper working conditions but sufficient money with which to buy proper living conditions, including house, food and clothing, for himself and his family. Anything that goes to the building up and making of health increases production and produces more revenue for the employer.

It has been estimated by the National Tuberculosis Association that on an average two and one-half years of life could be added to the mean after life-time of every individual in the United States if tuberculosis could be removed as a cause of death. This would mean a gross saving of at least \$25,000,000,000 to the industries and people of this country. To eliminate the disease would cost probably in the neighborhood of \$2,000,000,000. Consequently any agency or movement which has this accomplishment as its purpose is worthy of widespread individual and organized support. The purpose of the National Tuberculosis Association and its allied agencies is to unite communities all over the United States, in order to secure the machinery and assistance necessary to prevent tuberculosis. The revenue for this great health- and life-saving movement is provided from the annual sale of Christmas Seals from Dec. 1 to 11.

Every dollar's worth of seals aims a strong blow at this disease.

### Industrial Autocracy And the Way Out

WILLIAM B. DICKSON, vice-president of the Midvale Steel & Ordnance Co., is the one man in the steel industry who has spoken out and said, what many no doubt have thought, that the present industrial system represents an autocracy in the control of the employers over the employees. Speaking at the fortieth anniversary of the American Society of Mechanical Engineers, Nov. 5, Mr. DICKSON referred in particular to the policy of the United States Steel Corporation, calling it a benevolent autocracy, benevolent in many splendid ways, but still an autocracy, and saying further: "The autocratic policy of this great industrial corporation is diametrically opposed to American ideals, and if it and similar organizations in other industries continue to grow and to maintain this autocratic attitude, there can be only one result—industrial feudalism, feudalism with a high degree of comfort and safety for the worker, I grant you, but none the less feudalism." The feudal barons owned the land and its appurtenances, the highways, streams, mines, fisheries, etc., while at the present day the corporations own plants.

Mr. DICKSON says American industry has now come to the parting of the ways, one way leading to industrial democracy, the other, camouflaged to appear as the natural continuance of the present road, leading to industrial feudalism, but with a bypath "now being trodden by Russia, and toward which not only our British brethren but a considerable number of American workmen are being tempted to stray."

Feudalism is cited as a horrible example of what the present industrial system represents or is trending toward. If, then, one should set up the problem, "How would you devise a way out of feudalism?" one reasonable suggestion would have been that the barons and workers should go into partnership and should divide the proceeds by shares. In the modern partnership the partners divide the profits according to a predetermined schedule.

Now it chances that the steel mills have had in practice for a long time this very system, only that it is not general. It is curious that Mr. DICKSON did not propose an extension of the system, so successful where it has been used, to all the workers. We refer, of course, to the "tonnage" basis of payment, and particularly to those systems in which the rate per ton varies according to the market or selling price of the material produced. That is vastly better than any so-called system of "profit sharing." Profits may be reduced by the mistake of a purchasing agent and the worker should not be expected to contribute toward the loss. The system is really a very common one. While in some cases the tonnage rate does not fluctuate with selling prices, that is doubtless because the workman does not wish to have it so. The system can be extended. Works managers are certainly ingenious enough to solve the problem. Where the work is collective a total sum could be allotted and the men be permitted to determine how many they desired should divide the pool. A blast furnace could then be operated with fewer men. That would be industrial democracy, a partnership among capital, management and labor, with the public sharing in the general prosperity that would inevitably accompany so happy a solution of the problem.



### Why Not Turn The Mold Over?

**R**ECENTLY in these pages the opinion was expressed that the American steel industry, speaking generally, was impelled by a desire for great tonnage rather than great quality. Such a state of affairs opposes the ideals of metallurgists, who quite naturally by their training, work first for excellence.

Sound steel—free of cavities, cracks, excessive segregation and non-metallic inclusions—is a difficult thing to make and precious. It would be a high goal for the ambition of many steel producers. Yet it is being made in this country in considerable quantity. Its makers realize that steel is not steel until it is successfully cast; given the best furnace practice at their command, making well settled and thoroughly deoxidized steel, they still exercise the most extreme care in getting it into the molds.

Take high-grade forging ingots as an illustration. Metal would probably be tapped into a clean, preheated ladle, running from the furnace somewhat too hot to pour. Fifteen or twenty minutes' cooling in the ladle allows trapped slag to separate cleanly. Ingots would probably be bottom-poured through runners proportioned so that the minimum of air would be drawn in with the steel by injector action, and poured just hot enough and fast enough that the surface of the metal rising in the mold would float islands of chilled metal like films of cream floating on milk. Molds themselves would be prepared and cleaned with the greatest care, so the advantages from complete lack of splattering might not be lost through particles of foreign matter, or the hot ingot sticking to the sides of a roughened mold. The mold itself would doubtless be bigger at the top than at the bottom, with thick bottom walls for great chill, thus insuring progressive freezing from bottom upward. Further to guard against secondary pipe, a sink-head of brick would be built on top the ingot, and charcoal or slag would be placed on top the liquid metal to retain it molten as long as possible. Such ingots would be lifted out of their molds while still red, and buried or soaked to insure slow cooling and prevent shrinkage cracking.

"But," it is objected, "this program is entirely too expensive for cheap products which do not require such high quality." Granted; but where does this idea lead?

You would make the steel in the ladle (or even in the ingot) rather than in the furnace, in order to increase the tonnage of the plant; you would cast fast and cold to enable the ingot to stand more abuse in blooming; the molds would be bigger below than on top because they are easier to strip; you would top-cast because it is cheap, and generally neglect the sink-head or hot top for the same reason; you would strip as soon as possible and remove to a soaking pit to save heat and perchance cure some of the ready made imperfections, and rush the rolling by heavy drafts to avoid reheating. In other words these things are exactly what a maker of quality steel does not do.

Generally speaking, when an American plant must produce sound metal, really sound, such as will make high-explosive shell forgings, it casts dead-melted steel and the Government will accept about 55 per cent of the ingot. If an English plant would cast the same metal it would be done in such a way that 85 per cent would be acceptable by inspectors no less keen to find

defects. It is not because we do not know how. Unquestionably the only reason American plants persist in making ingots with internal cavities is because only about one-eighth of their total production is dead-melted steel and of this they are able to work off on unexact purchasers up to half what is defective and should really be discarded.

Evidently, a seeker for sound ingots—really sound—must disregard particular plant layouts, big outputs and apparent economies. His way unquestionably will be hard, but he will be assisted by the inevitable trend of future demand, and eventually he will succeed.

With so many points of attack it is only necessary for one desirous of increasing ingot quality to select the most vulnerable and the one most likely to yield the greatest results for the energy expended. That appears to be the taper of the molds. Apparently a small point, but it has been so often demonstrated by theory and practice that in a big-end-up ingot the pipe is shorter and higher up, as compared to the same mold inverted, that no discussion of the reasons is necessary here. Big-end-up ingots have been used in France and Germany for forty years or more; their use has always been one of the causes of the excellence of Swedish metal, and, impelled by war's demands, the English have widely adopted the practice in these recent years. Even Americans use the idea to the extent of making perhaps a million tons a year, mostly in highest-grade forging ingots, or high-carbon or alloy steels. But even so, some notable pioneers have even discovered that it pays on the more common grades.

Many special methods of reducing pipe and limiting segregation have been regularly used in American mills for the past five years. But they have all compromised with the big-end-down fetish. Their users have realized that to prevent a pipe you must feed it, and therefore simulate the clay "dozzle" with which the crucible steel melter caps his mold, by making it thin at the top, insulating it with fireclay, building sink-heads, or actually heating the top by outside flame. But they seemingly have dodged the fact that a big-end-up casting provided in itself an upper reservoir of metal hot to the last, and which, if assisted by their ingenious sink-heads, would without peradventure absolutely prevent secondary pipe and give up to 85 per cent "sound" metal, something their half-way steps have not yet insured.

It is not the intention to lecture the American metallurgist on the exact procedure he must follow in furnace, casting, molds and soaking in order to eliminate internal cavities. It is the intention, however, to emphasize as clearly as possible that most of the present defects are due to the lack of discrimination among American steel users, and the insistent demand for tonnage production from the steel-works' management. We hold no brief for HADFIELD, GATHMANN, BRADFORD, or any of those sturdy men, except in our poor way to support their efforts toward getting sound metal. We have tried to point out that American steel-making practice has had the tonnage idea for a goal. It is time now to look for quality. We propose a forward step which need not be postponed years—in case a manager wanted to do it it could be done within a month.

As one might say, "Turn the mold over."

## Notes on French Industries

FROM OUR PARIS CORRESPONDENT

*Paris, France, Oct. 15, 1920.*

A GREAT number of our people persist in qualifying as abnormal our present economic situation. In fact, after the cataclysm we passed through during the last few years, we and all the rest of the world find ourselves today in quite a logically resultant situation. It is wrong to compare our present status with that of the pre-war period, because it is bound to create a pessimistic spirit at a time when we need to be so very optimistic.

These reflections are the more apparent now when we are threatened with a very grave and profound economic crisis. Credit is becoming more and more restricted and the money stringency has already reached a very acute stage. A great number of manufacturers, fearing an endless rise in prices of raw materials, have accumulated enormous stocks at high prices, and have transformed these expensive materials into finished products at high costs; but now when a general decline in prices is expected and the demand for the finished products has fallen until it has quite disappeared, manufacturers and consumers find themselves in a peculiar position. The manufacturers do not wish to sell at a loss, and the consumers delay their buying as long as they can.

The fall in prices has already begun; it started with metallurgical products. The government, which controls the importation of coke, has already limited the price of metallurgical coke to 175 fr. (normal value \$35) per ton instead of the former 275 fr. (normal value \$55) per ton. This was done in agreement with the officials of steel plants. The consequence was a drop of the prices for hematite pig iron from 850 fr. (normal value \$170) to 700 fr. (normal value \$140) per ton and a 20 per cent drop in the prices of finished steel products. This is a beginning.

### FRENCH HYDRAULIC POWER

According to a very recent study made by the writer on the subject of French hydraulic power, the following data may serve to complete the succinct information given in the preceding letter (see *CHEM. & MET.*, Oct. 20, 1920, p. 764):

Before the war the sum invested in the hydro-electric industry amounted to over a billion francs (normal value \$200,000,000). It was estimated that the investments were apportioned as follows: 525,000,000 fr. (\$105,000,000) for power and light; 100,000,000 fr. (\$20,000,000) for electrochemical and electrometallurgical industries; 75,000,000 fr. (\$15,000,000) for electric railways; 300,000,000 fr. (\$60,000,000) for sundry small industries.

Taking as an average 800 fr. (\$160), the pre-war installation cost per horsepower, it would follow that up to 1914 there was installed in all France about 1,250,000 hydro-electric horsepower.

During the war France made great strides for further hydro-electric development, and from 1914 to 1918 500,000 more horsepower was installed at a cost about double the pre-war cost, so that at present there are in operation hydro-electric power plants installed at an estimated total cost of 2,000,000,000 fr. (\$400,000,000).

A government commission is now studying the

development of all the French waterfalls not yet used and which are estimated to represent 10,000,000 horsepower. Projects are under way for the installation of plants aggregating 3,000,000 horsepower. This installation will enable France to make important coal economy. (There is under way a project for electrifying 8,000 km. [about 5,000 miles] of railroad, which if realized would result in an annual economy of 3,000,000 tons of coal.) It is estimated that the cost of reclaiming the 3,000,000 horsepower would amount to about 4,000,000,000 fr. (\$800,000,000), and could be finished within fifteen years. It is expected that the report of the commission will soon be presented to the French Parliament.

To the above-estimated 10,000,000 hydro-electric horsepower available in France may be added about 400,000 horsepower which could be obtained by using the Rhine falls between Basel and Strassburg as provided in the Versailles treaty. But to reclaim this power it would be necessary to build a canal entirely situated on French soil.

Although this would open direct water communication from Basel to the sea for ships up to 1,200-ton size, the Swiss Government is strongly opposed to the plan and bases its contention on the Oct. 17, 1868, treaty of Mannheim guaranteeing the free navigation of the Rhine. The Swiss ask that instead of a French canal the bed of the Rhine between Basel and Strassburg shall be rendered navigable. It is quite evident that England will back up the Swiss contention.

### FRENCH CHEMICAL ENTERPRISES

Due to the depreciation of money, the French chemical enterprises have been forced to increase their capital stock. Thus the Société de Saint-Gobain has increased its capital stock from 60,000,000 fr. (\$12,000,000) to 120,000,000 fr. (\$24,000,000). This society, founded during the seventeenth century, although quite conservative in its technical processes, is commercially well managed and is one of the strongest mineral chemical enterprises. It has a number of plants in France, a branch installation in Mannheim on the Rhine and is now planning to build a new plant in Strassburg.

The Société de Saint-Gobain has recently become financially interested in the Claude process of synthetic ammonia and contributed to the increase of capital of the society of L'Air Liquide, a company working Claude's processes. If the rumors are right the Saint-Gobain society would absorb entirely the company L'Air Liquide and start on a big scale the manufacture of synthetic ammonia by the Claude process.

During the last month the daily production of synthetic ammonia in Claude's experimental plant has increased tenfold, now producing 1.5 tons per day. It is the Saint-Gobain company's intention to bring up the production to compare favorably with the German 1,000-ton-per-day production by the Haber process.

The Etablissements Kuhlmann has also increased its capital stock to 80,000,000 fr. (\$16,000,000). This company grew rapidly during the war. Like the Saint-Gobain company, it manufactures mainly mineral chemicals and has also started in the synthetic ammonia industry, but using the Haber process, which has been bought by the French Government for 50,000,000 fr. (\$10,000,000).

The development of these two rival branches will have a great influence on the French synthetic ammonia industry.



## Pure Metallic Arsenic

**Occurrence—Description of Process in Plant of the Hoskins Process Development Co. of Chicago, Which Produces a Quantity of Metal Equal to the Requirements of the United States—Properties of the Metal—Crystalline Structure—Uses in Metallurgy**

BY CHESTER H. JONES

THE term "arsenic" in commerce is usually misapplied to the trioxide ( $\text{As}_2\text{O}_3$ ) instead of the elementary or metallic arsenic which exists at ordinary temperatures. It is with the latter substance this article attempts to deal. Previous to the late unpleasantness there was an importation of the metal to the United States of about 50,000 lb. (22,720 kg.) per year, principally from Germany, where it had been distilled direct from arsenical ores. Subsequently the production has been developed in a Chicago plant to meet the present demand in this country. The raw material for this plant is the arsenic trioxide, or white arsenic, a byproduct from metallurgical operations at various American smelters.

While metallic arsenic is found in the natural state

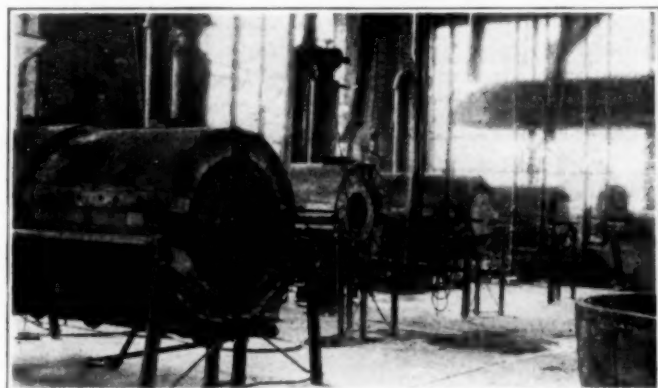


FIG. 1. ARSENIC REDUCTION FURNACES

in some districts, it more commonly occurs in ores in combination with other elements such as:

- Cobaltite,  $\text{CoAsS}$ .
- Mispickel,  $\text{FeAsS}$ .
- Smaltite,  $\text{CoAs}_2$ .
- Mimetite,  $3\text{Pb}_3\text{As}_2\text{O}_7 \cdot \text{PbCl}_2$ .
- Nickel glance,  $\text{NiAsS}$ .
- Orpiment,  $\text{As}_2\text{S}_3$ .
- Realgar,  $\text{AsS}$ .
- Scorodite,  $\text{Fe}_2\text{O}_3 \cdot \text{As}_2\text{O}_5 \cdot 4\text{H}_2\text{O}$ .
- Sperryllite,  $\text{PtAs}_2$ .

Most of these minerals are found in varying quantities in the gold, silver, lead, copper and zinc ores, particularly in our Western mining districts.

Investigations in connection with proposed legislation against smelter fumes in these localities led to belief that the arsenic vapor contained in the fumes issuing from the stacks was largely responsible for the destruction of vegetation and injury to animal life. The operating companies have consequently been forced to recover the arsenic in Cottrell precipitators and bag houses, and on subsequent refining by sublimation have recovered arsenic trioxide. The trioxide obtained from

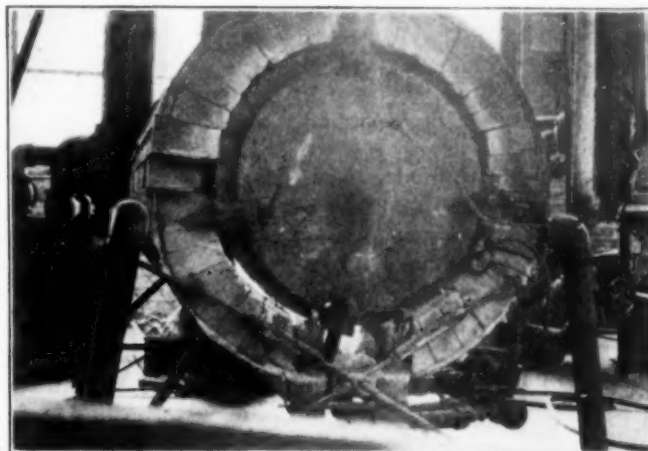


FIG. 2. CHARGING END OF FURNACE

these smelters and plants roasting high-content arsenic ores gives the supply of raw material for the operations described in the following paragraphs.

### HOSKINS PROCESS DEVELOPMENT CO. PLANT

The one plant in the United States making metallic arsenic of a guaranteed purity over 99.5 per cent is located in the west side manufacturing district of Chicago. Fig. 1 shows the battery of four reduction furnaces, one large and three smaller, having a total capacity of 250 to 300 lb. of metal per day.

The charge with proportions consisting of about 1 lb. of wood charcoal to 4 lb. of arsenic trioxide is placed in a rotary mixer. The mixed batch for charging to the small furnace weighs about 200 lb. and for the large furnace about 450 lb. Fig. 2 shows the charging end of the large furnace in operation.

In Fig. 2 the gas flame may be seen beneath the

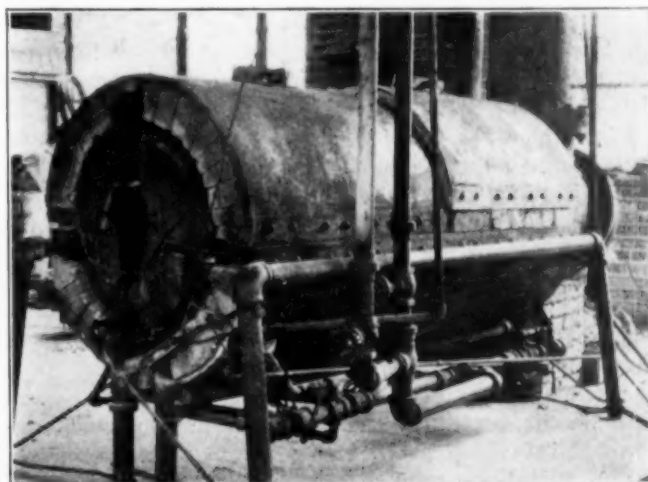
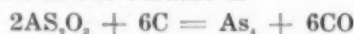


FIG. 3. RIGHT SIDE OF FURNACE



retort and the pyrometer leads coming from the cover. All four furnaces are equipped with pyrometers using nickel-chromium couples and connected through a multiple switchboard to give temperature reading on each furnace. The temperature varies between 1,200 and 1,300 deg. F. (650 and 700 deg. C.).

The reaction in the furnace is



These furnaces are built of large steel pipe surrounded by No. 1 firebrick held in place by riveted steel plates, all supported on pipe framework. Fig. 3 shows the arrangement of gas piping. The water-cooling supply for the charging end cover is conducted through the smaller pipe. This cover is clamped against a clay gasket in which is buried a  $\frac{1}{2}$ -in. copper pipe filled with the cooling water. In case of any leak of the arsenic fume it condenses against the cooled surface, rendering the joint tight.

The water supply for both the condenser appearing at the rear end of furnace in Fig. 4 and for the gasket cooling-coil mentioned in the foregoing paragraph consists of a  $\frac{1}{2}$ -in. stream running continuously from the city mains.

The period of operation for the large furnace occupies about ten hours and for a small furnace seven hours. Running under normal conditions the plant produces not

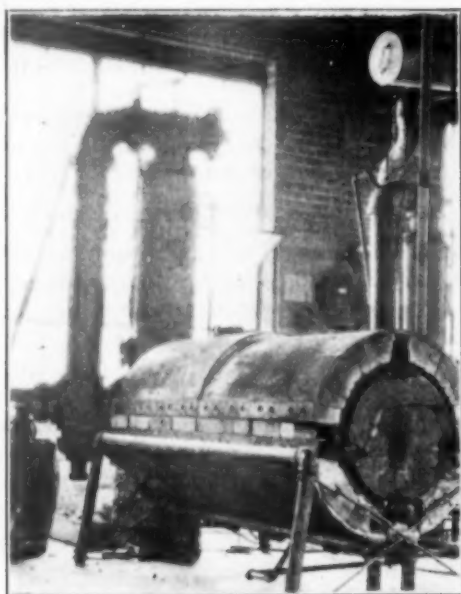


FIG. 4. LEFT SIDE OF FURNACE

less than 4,000 lb. of metallic arsenic of 99.5 to 99.9 per cent purity per month. The small impure fraction consists chiefly of arsenic trioxide.

Fig. 5 shows the rear end of the battery with pans containing the lumps of metal immediately beneath the point of removal. When the run is finished and the furnace has been allowed to cool, the cover clamps are removed, permitting the cover to be taken off. The crystalline metal which has been formed in the tee, by carefully controlling the temperature and pressure during the heat, is taken out with bar and hammer. It is then ready for barreling and shipment.

A feature of safety to prevent poisoning of the operators is the ventilating arrangement and exhaust fan. Two of the small hoods connected to the system are shown just above the discharge end. The operators wear woolen masks over the nose to avoid injury from

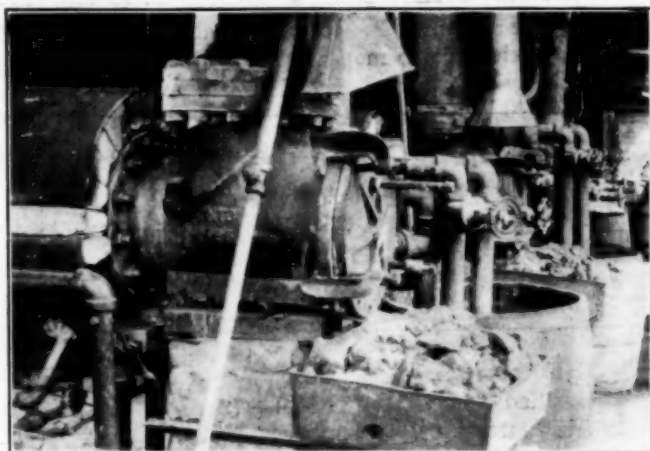


FIG. 5. DISCHARGE ENDS OF FURNACES

the fumes or dust. With these precautions the danger from poisoning is negligible. There are many features of this process which have required a period of several years before the ultimate production in the commercial plant described.

#### PROPERTIES OF ARSENIC

Metallic arsenic ( $\text{As}_2$ , molecular weight 300) is classified with nitrogen, phosphorus and antimony in the periodic system. It is chemically analogous to phosphorus, but is more metallic in character. As a metal it behaves like sulphur. Thus the sulphides and arsenides have similar formulas, are isomorphous, and in them sulphur and arsenic can mutually replace each other in atomic ratios—e.g.,  $\text{FeS}_2$ ,  $\text{FeAs}_2$ , and  $\text{FeSAs}$ .

The characteristics of the three metallic varieties when condensed in a glass tube from distillation of arsine in the laboratory are well known. Nearest the flame the crystals form, further on the shining mirror and finally the amorphous. The last is microcrystalline, probably isometric, and black with little luster. It has a specific gravity of 4.71 and when heated to 360 deg. C. out of contact with air sets heat free and reverts to the larger crystalline variety.

The vapor density of metallic arsenic corresponds to the molecular weight,  $\text{As}_2$  ( $= 300$ ), with the lemon yellow vapor at 450 deg. C. At white heat, about 1,700 deg. C., the density falls to one-half, or  $\text{As}$  ( $= 150$ ), showing the diatomic molecule.

The crystallized variety, which is the normal product of these furnaces, so far as has been investigated, varies from the hexagonal to acute rhombic octahedra. It has a specific gravity of 5.73, is brittle and may be pulverized without difficulty. The hardness is 3.5 (Mohs

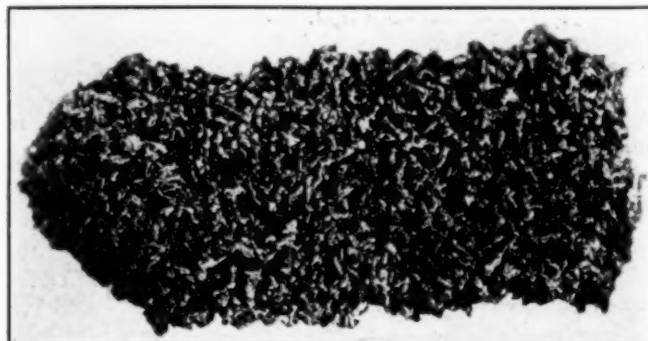


FIG. 6. METALLIC ARSENIC CRYSTALS (SLIGHTLY REDUCED)

scale); the luster is tin-white metallic, tarnishing to black by oxidation in moist air at ordinary temperature and gives a tin-white streak. The cleavage is perfect basal, the fracture granular.

Figs. 6 and 7 show crystals taken at random from the run of furnace and indicate plainly the clean nature of the commercial product. Arsenic in metallurgical classification lies between the true metal and the non-metal. It behaves in certain ways like the one and in other ways like the other. It will form alloys in some cases and is thrown out of the molten mass or forms "speiss" with others. Although a metalloid, it is a good conductor of heat and electricity.

#### USES

The metal acts in the nature of a flux for other metals, promoting the union of metals which would otherwise be difficult to mix. The trioxide cannot be successfully substituted for the metallic arsenic in the work. Arsenic bronze, now used for railroad brasses, is a good example. (Composition: Copper 80, tin 10, lead 10, arsenic 8.) The structure remains unchanged, but there is a gain in crushing strength and a lower temperature is required to crystallize. A content of 0.65 metallic arsenic increases the resistance to hammering.

The arsenic may be added directly to the molten metal, or a rich alloy of arsenic with copper or lead may be made and proper proportions of it used.

It seems to be the consensus that a small percentage of arsenic added to copper to be used in sheets, tubes,

Arsenical lead contains about 2 per cent arsenic. The product is harder, but the more important property of increased mobility of shot when molten is secured. This results in a more uniform output from the shot tower.

Metallic arsenic is also used in the manufacture of speculum metal for mirrors in large telescopes.

#### CONCLUSION

We have, then, a process and plant perfected by American chemists producing on a commercial scale an element of guaranteed purity and known to be useful in the improving of a few of our metals for important uses. But the field is scarcely touched as yet, the research is only in the preliminary stages, and we may venture to hope for much in future developments. To have at hand a pure metal, to find these new things it will do with other pure metals, its behavior in many eutectic mixtures, and all its meanderings through the wide field of chemistry with ultimate benefit to industry at large—this is a thing worth while.

We are indebted to the Hoskins Process Development Co. for the material contained in this article.

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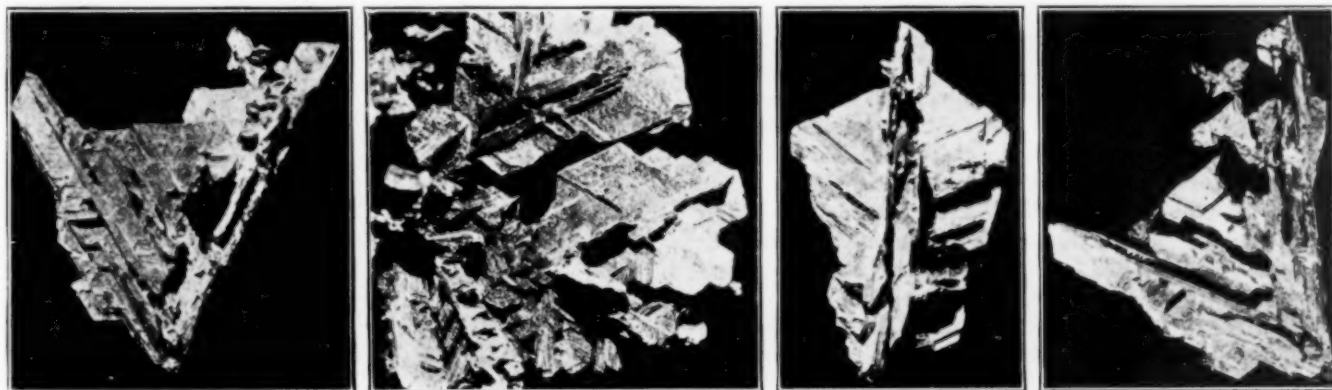


FIG. 7. COMMERCIAL METALLIC ARSENIC CRYSTALS ( $\times 34$ )

staybolts, etc., for locomotive fireboxes will increase the tensile strength, rigidity, hardness and resistance to action of gases as compared to pure copper. Added to copper for castings it reduces blow-holes and increases fluidity. Copper to be drawn into wire works better in the drawing process and the melting point and conductivity are lowered.

The annealing point of copper is raised by the addition of arsenic, and a tougher metal results. The injurious effect of small quantities of bismuth is counteracted. Arsenic tends to deoxidize the copper.

A higher percentage of lead may be carried in a zinc alloy by the addition of metallic arsenic.

When added to brass for casting up to 0.5 per cent, it increases the fluidity when molten, gives sharper and cleaner castings and increases the strength and elongation. It increases the ductility of Muntz metal (60 copper, 40 zinc).

A finer grain and increased hardness is secured by adding metallic arsenic to white bearing metals.

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## The Indian Mica Industry

MICA is one of the things, like jute, for which for certain purposes no satisfactory substitute has been discovered, and although it is not, like jute, an Indian monopoly, more than half the world's supply of the mineral comes from that country. In India it is very widely distributed, but the tracts in which it is found in plates of sufficient size to have a marketable value are few and strictly defined. Mica in more recent years has been mined in the Nellore district of Madras, but the main deposit is in a belt about eighty miles long and twelve broad, which lies in the northern part of the Hazaribagh district and stretches into the adjoining districts of Gaya and Monghyr. The main center of the industry is at Koderma, in the Hazaribagh district.

### PRIMITIVE METHODS OF MINING

Mica does not occur in thick seams like coal, but in small deposits or "books," and a mica mine or quarry presents the appearance of a huge rabbit warren, the workers burrowing from "book" to "book" by passages that are sometimes just sufficient to admit a small boy. In most cases very primitive methods are used, the lower levels of the mine being reached by roughly made bamboo ladders and the excavated material being passed, hand over hand, from one coolie to another. The bailing out of water is done in the same way by the use of buckets, and during three months in the monsoon operations may be suspended altogether, the mica being under water. In one of the mica districts, before the war, a German firm was the only one of the many agencies at work that employed a steam pump. As the demand for the mineral has increased and the deposits near the surface have been worked out, more scientific methods

for extracting the mineral are gradually being introduced, and mica is now being dug by means of shafts 300 to 400 ft. deep.

### USE OF MICA IN THE ARTS AND MEDICINE

Mica has been extensively used in the native arts of India from time immemorial. The powdered mica is used in calico printing and by washermen to give a sparkle to cloth. It is a substitute for glass in lanterns, and the material out of which "unbreakable" lamp chimneys are manufactured. It fills the peepholes of furnaces, and is used for windows in cases where glass would break on being exposed to extremes of heat or to concussion. It is a glazing material for pottery, for pictures, and for the backs of mirrors. Indian artists have used it largely for paintings.

Mica also has a high reputation in Indian medicine. It is used as a finely ground powder, either by itself or in combination with other drugs; it is said to be a tonic. Indian medicine classifies nearly all drugs and articles of diet into two groups—the "heating" and the "cooling"—and mica is said to be the most efficacious of all the drugs in the latter class. It is said that some Indian practitioners have a secret means of dissolving mica, but this is doubtful. Such solvent would be a great discovery, for it would mean that mica could be used for the manufacture of unbreakable tumblers and decanters.

### A NON-CONDUCTOR OF HEAT AND ELECTRICITY

"Mica paste" or "mica grease" is used as a lubricant and to plaster on boilers to diminish the loss of heat, for mica is a non-conductor of heat. It is believed to be the chief constituent of the preparations that are used for painting the under side of iron roofs to promote coolness and for other similar purposes, and it has been recommended, and actually used, as a lining for sun helmets.

The main importance of mica in modern industry, however, lies in the fact that it is one of the best non-conductors of electricity and is, therefore, indispensable in electrical engineering. On this account the government took over part of the mica field during the war and worked it as a state industry in order to make sure of having a constant supply.

### "MICANITE"

Impetus was given to the industry about twenty years ago by the invention of a method of cementing small pieces of mica together and molding them into sheets, which are called "micanite." In former days it was said that 80 per cent of the mica which was dug out of the mines was waste, and great waste dumps of the refuse, glittering in the sun, were a conspicuous feature of the mica mines and factories where the splitting was done. Since this process of welding was introduced a considerable amount of marketable mica has been recovered from the waste heaps, and the process also permits the use of a larger proportion of the mineral that is excavated.

### UNSKILLED LABOR EMPLOYED

The industry gives work to a large number of unskilled laborers. Even the work in the factories, where the thick pieces are split into thin sheets and cut to the proper sizes, is easily learned by women and children, and a daily wage can be earned that is considerably in excess of what is paid for field work.





PLANT OF THE HOOKER ELECTROCHEMICAL CO., NIAGARA FALLS

## Chemical Efficiency and Concentration of Caustic and Salt From Townsend Cells\*

Brief Description of the Townsend Cell Installation of the Hooker Electrochemical Co.—Some Characteristic Properties of Saturated Cathode Liquors—Concentrations and Equilibriums of NaCl-NaOH Solutions—Chemical Efficiency

By ALBERT H. HOOKER

**D**R. BAEKELAND in 1907 described the general principles of the Townsend cell and process of operation in the *Journal of the Society of Chemical Industry* and *Electrochemical and Metallurgical Industry*.<sup>1</sup> Since that time there has been a large development in the production of chlorine from these cells and some material modifications in design and operation have taken place. For that reason it seemed proper to bring before this symposium on electrolytic cells a brief description of the plant of the Hooker Electrochemical Co. at Niagara Falls, where we are producing about sixty-five tons of caustic soda and sixty tons of chlorine daily from Townsend cells.

\*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

<sup>1</sup>Now CHEM. & MET. ENG.

The heading of this article gives a general view of the plant covering about thirty-eight acres. In the left foreground will be seen the research laboratory; behind that the chlorbenzol plant, where about thirty tons a day of chlorbenzol was made during the war for the French Government to convert into dinitrophenol to modify its picric acid explosive; near that will be seen the plant for the manufacture of a very pure grade of muriatic acid, practically water white. The two larger buildings are the boiler plant, with a modern equipment of mechanically stoked boilers used to supply heat and steam for evaporation and process work, and one of the evaporation houses containing vacuum pans and pots for finishing caustic. The two power houses, five cell buildings, bleach chambers, brine purification tanks, machine and repair shops, office building, general labo-



FIG. 1. CELL HOUSE

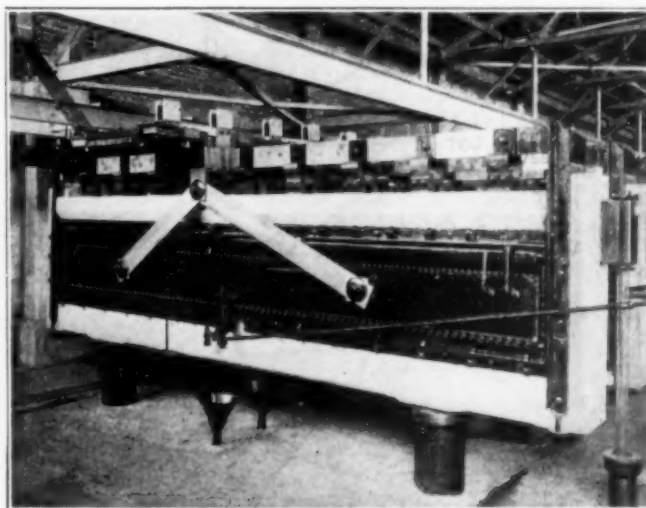


FIG. 2. 4,000-AMP. TOWNSEND CELL

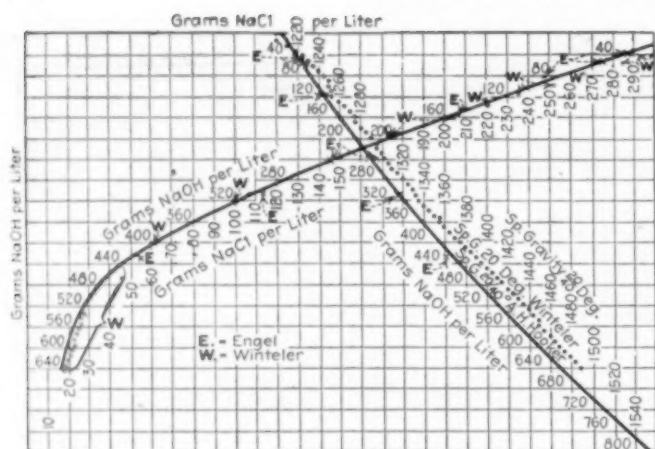


CHART 1. SP. GR. AND GRAM/LITER OF SAT. NaCl-NaOH SOLUTIONS

ratories, liquid chlorine and synthetic chemical units form the general group to the right of the picture, while in the distance can be seen the plant where we made picric acid for the Government from monochlorobenzol during the war.

#### TYPES OF TOWNSEND CELLS

This work all centers around the production and use of chlorine and caustic soda from the Townsend cells.

The power is received from the Niagara Falls Power Co. as three-phase, alternating current at 12,000 volts, and after passing through transformers and rotary converters is delivered to the cell circuits at about 260 volts and 4,000 to 5,000 amp. direct current.

We have several types of Townsend cells in operation, a small circuit of the original 2,500-amp. cell and some of the earlier 5,000-amp. cells. However, Fig. 1 shows

one of our more recent cell bays, which consists entirely of 4,000-amp. cells. In the building there are 120 cells, each with a daily output of slightly over 300 lb. of caustic soda, or a total of eighteen tons. Fig. 2 is a more detailed view of one of these cells, which is of the long, low type of large capacity.

We find it expedient at Niagara Falls, with existing power costs, to run at exceptionally high current densities, about 100 amp. per sq.ft. of cathode, and hence use a little over four volts per cell during an average run, and an ampere or current efficiency of between 96 and 97 per cent. Owing to the circulating system which we use to maintain saturation, as well as the novel use of oil in the cathode compartment, we are able to obtain this efficiency with a caustic strength considerably above 125 g. NaOH per liter.

Another interesting group of cells is the corrugated type of low cell. The previous design was intended to give the maximum horizontal surface of cathode consistent with a large unit and the simplicity of the straight side plates. The cell was designed to crimp this plate accordion fashion and thus permit a much greater horizontal surface for the escape of gas within the same ground area. This was intended to reduce materially the voltage of the cell at the same current density.

In this bay of 5,000-amp. cells the result of lower voltage is fully accomplished and a natural saving is made in the cost of both installation and power. The design still requires some perfecting to work out a perfect diaphragm control and simplicity of renewal repairs. Consequently, while power costs are low, the chemical efficiency is not quite as good—say 93 or 94 per cent.

When it comes to a final monthly balance sheet with

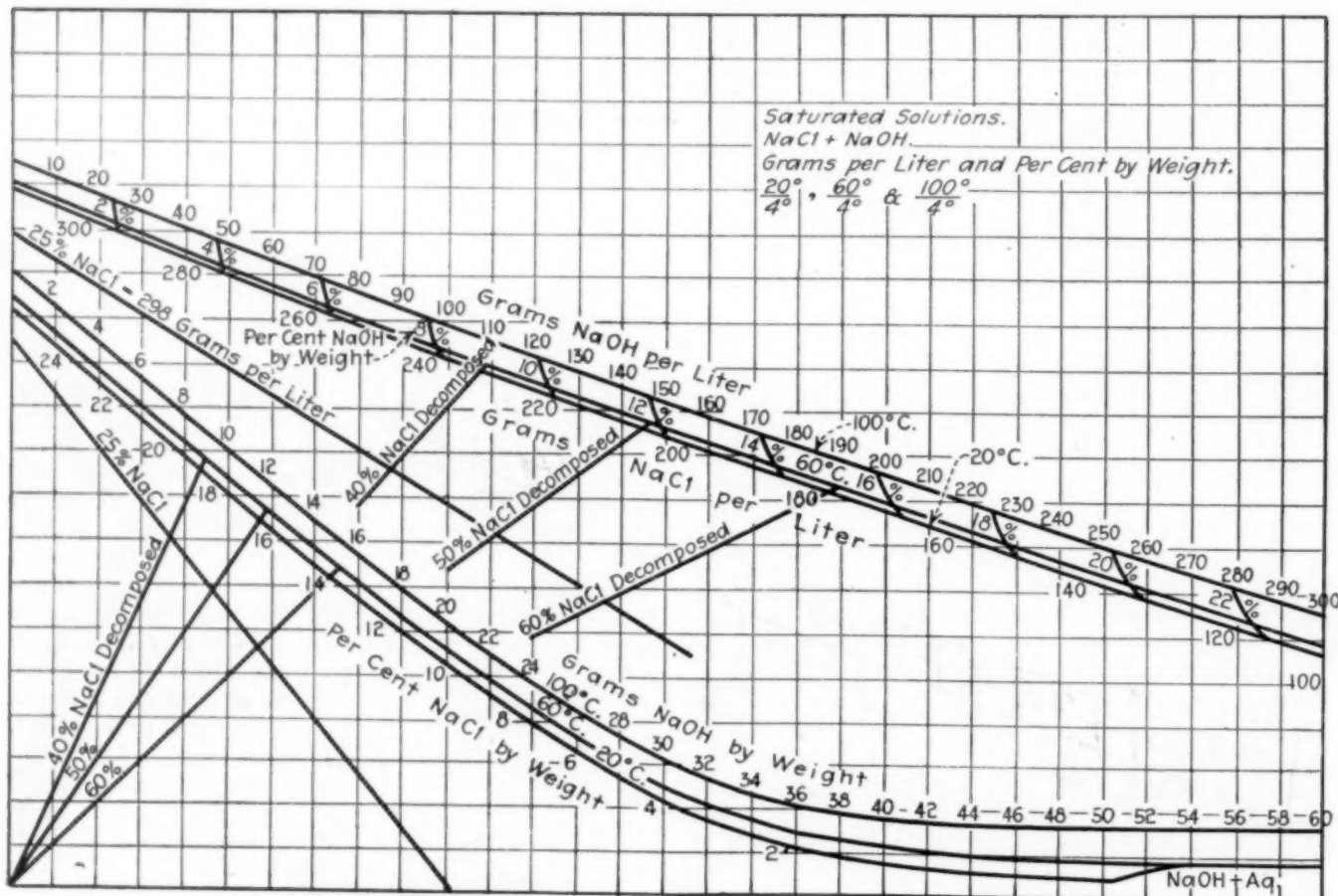


CHART 2. PER CENT BY WT. AND GRAM/LITER SAT. NaCl-NaOH SOLUTIONS



Niagara Power costs the two groups run a very close commercial race, but there are other locations where a choice might clearly point to either one of the two types as the better.

A study of the cathode liquors from these different types of cells has led to some interesting results, which it is my hope to bring out in the paper which follows.

#### CATHODE LIQUOR DATA

Solutions saturated with NaOH and NaCl at various temperatures form the products which we are constantly handling in dealing with cathode effluent from diaphragm cells used in the production of caustic soda. Winteler has given a very full table showing the grams per liter of NaOH and NaCl as well as specific gravity of the solutions saturated at 20 deg. C. This table has been very freely used and is found in most of the literature, English, German and French, dealing with this subject. Engel has given a more limited series of observations not so generally used and based on determinations at zero and 15 deg. C.

I had occasion in 1911 or thereabout to use the figures of Winteler reduced to per cent by weight by use of his specific gravity determinations, and from these figures very slightly modified prepared a number of rather complete saturation curves. Some of these I had intended to use in this paper. However, experience has clearly shown that there were some material errors, particularly in the specific gravity determinations of Winteler. I have, therefore, re-determined many of these figures and submit new figures which I hope with your criticisms and corrections may form a substantial basis for future calculation. I might add that Winteler's figures considered only as grams NaOH and NaCl per liter agree closely to my own observations over the important range of the curve. The specific figures offer the serious difficulty. Engel's figures, in general, agree much more closely in all regards, although the range is more limited. Chart 1 shows the essential differences and corrections which I have made and use in subsequent charts. Chart 2 shows both per cent by weight

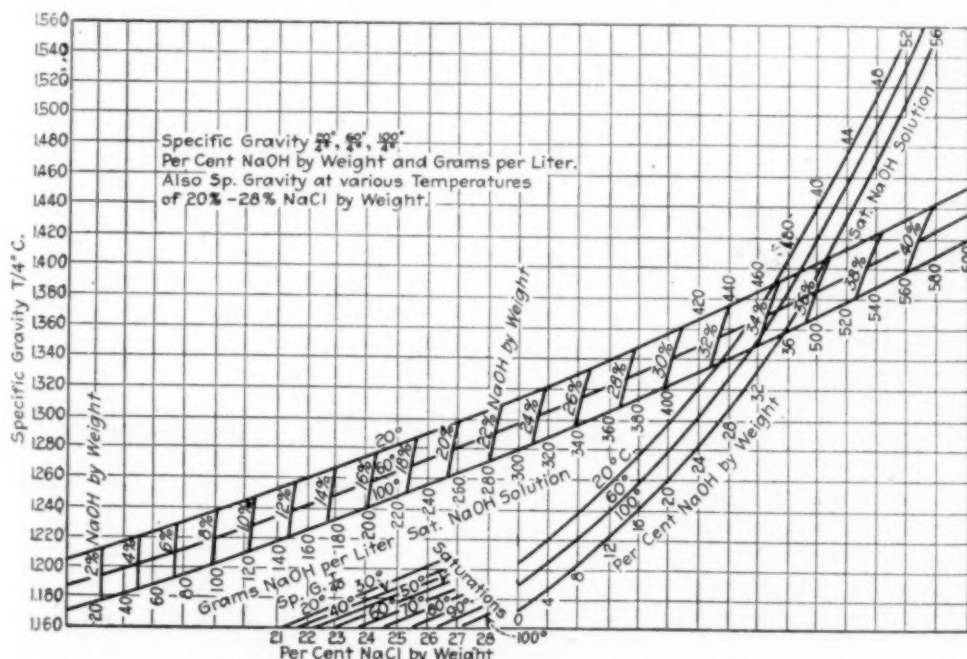


CHART 3. SPECIFIC GRAVITIES AT 20 DEG., 60 DEG. AND 100 DEG. C. OF NaCl-NaOH SOLUTIONS

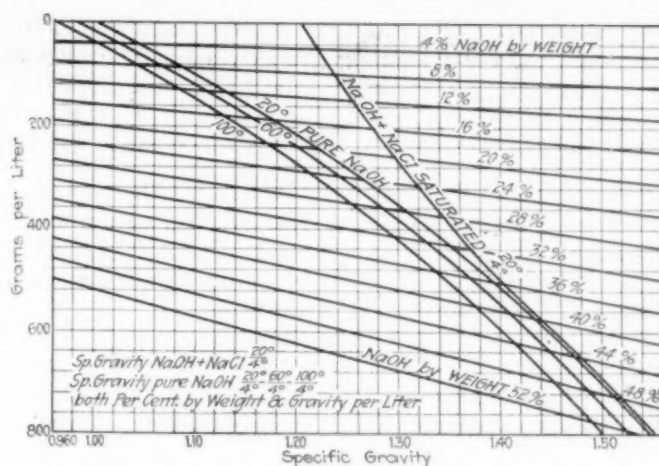


CHART 4. SPECIFIC GRAVITIES OF NaOH AND NaCl-NaOH SOLUTIONS

and grams per liter of saturated solutions of NaOH and NaCl at 20/4 deg., 60/4 deg., 100/4 deg. Chart 3 shows the corresponding specific gravities for these solutions. Chart 4 shows specific gravity 20/4 deg., 60/4 deg., 100/4 deg. for pure NaOH solutions, and, incidentally, for saturated NaOH and NaCl solutions at 20 deg. C. This chart I have purposely ruled to bring out one feature which I found was not generally considered by our chemists in preparing curves and which I find quite useful. If a sheet of cross-section paper is prepared showing grams per liter on the lower margin and specific gravity on the side margin, say with a range in specific gravity from 1.000 to 1.500, obviously a line ruled from 100 g. per liter at 1.000 specific gravity connecting 150 g. per liter at 1.500 specific gravity will represent a 10 per cent solution by weight at any intermediate specific gravity. A corresponding line from 120 g. per liter at 1.000 specific gravity to 180 g. per liter at 1.500 specific gravity will represent a 12 per cent solution by weight at any intermediate specific gravity and to paper ruled in this way can be transferred figures either in per cent by weight or grams per liter at will, and both readings can be made from the same chart.

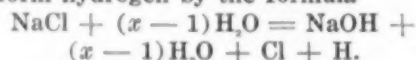
These figures for pure NaOH solutions at 20 deg. agree closely with Lunge's tables at 15 deg. with the necessary temperature correction. However, Lunge has published an extensive table showing the change in specific gravity with temperature. I cannot make my own observations agree with Lunge's as to change in specific gravity with temperature, hence offer these figures at 60 and 100 deg. for criticism and, I believe, correction of Lunge's figures. Chart 5 gives the specific gravity and per cent by weight and grams NaCl per liter over a full range from 20 to 100 deg. C. Chart 6 shows the solubility of chlorine in water and in brine of various strengths and a full range of tem-



peratures. Also the solubility in grams of chlorine per liter and the corresponding grams NaOH which would be converted by this chlorine into hypochlorite in the cathode compartment of a cell. These first six charts are presented as the basis for those which are to follow.

#### ECONOMICAL SALT DECOMPOSITION

If we consider in rather simple terms the reaction which takes place on electrolyzing salt in a diaphragm cell we can express it after the sodium has decomposed water to form hydrogen by the formula



In ordinary operations there is a certain ratio of salt decomposition which offers the greatest economy for a

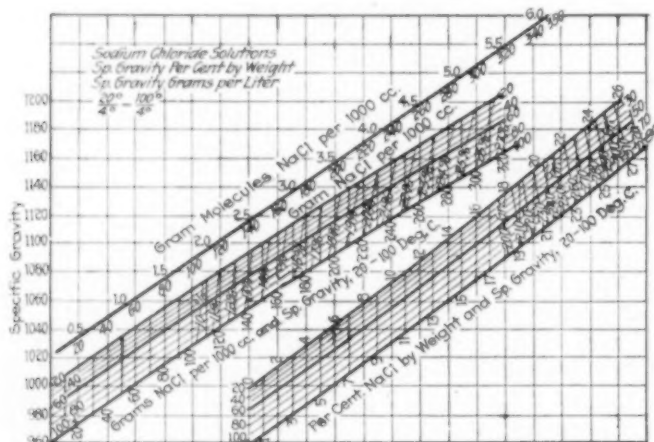
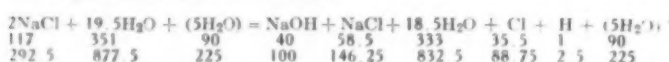


CHART 5. SPECIFIC GRAVITIES OF NaCl SOLUTIONS

given cell—giving due consideration to the cost of power, coal, renewals, etc. This range is usually between 40 and 60 per cent salt decomposition. Assuming for consideration an intermediate figure of 50 per cent and the use of 25 per cent brine by weight, also a formula which will express the brine depletion in the anode compartment without resorting to transport numbers, we have the following:



117 351 90 40 58.5 333 35.5 1 90  
292.5 877.5 225 100 146.25 832.5 88.75 2.5 225

#### FEED BRINE

292.5 NaCl = 25 per cent by weight  
877.5 H<sub>2</sub>O = 75 per cent by weight

1170.0 = 981 c.c. = 298 g. per liter

#### CATHODE NaOH

100 NaOH = 9.27 per cent by weight = 111.8 g. per liter  
146.25 NaCl = 13.56 per cent by weight  
832.50 H<sub>2</sub>O = 77.17 per cent by weight

1078.75 = 894 c.c.

#### ANODE BRINE WITHIN THE CELL

292.5 NaCl = 20.96 per cent by weight  
1102.5 H<sub>2</sub>O = 79.04 per cent by weight  
1395.0 = 243 g. per liter

We can entirely disregard efficiency in this formula and express the result in terms of product, and efficiency as the time or amperes needed to produce 100 g. NaOH.

#### WATER AND SALT CONTENT OF CATHODE LIQUOR

Turning now to chart 7 we have charted the results of 20, 25 and 26 per cent solutions of NaCl by weight at any rate of decomposition in terms of H<sub>2</sub>O and NaCl per 1,000 NaOH, which represent the simplest values for a direct commercial valuation of cathode liquors in terms of coal or evaporation costs.

Next on this same chart from our previous saturation curves are plotted saturated solutions of NaCl + NaOH

at 20, 60 and 100 deg. Now, it is well known that the Townsend cell as operated at our Niagara Falls plant uses an extensive circulating system both to remove impurities in the brine and therefore increase the life and efficiency of the diaphragm and to maintain the desired degree of saturation within the cell at all times. We can thus obtain a cathode solution that is fully saturated at 20 deg. In fact, with a temperature of 60 deg. within the cell we can readily exceed this point, but care must be taken not to do this except to a slight degree, otherwise trouble results from salt deposits at various points.

Turning now to our chart we find the following results:

50 per cent decomposition	50 per cent decomposition
25 per cent brine	Brine circulated and saturated
1,000 NaOH	1,000 NaOH
1,462.5 NaCl	1,462.5 NaCl
8,325 H <sub>2</sub> O	6,250 H <sub>2</sub> O

This difference then is 2,075 lb. water per 1,000 lb. NaOH produced. Nor is this the only difference. We have seen that there was required 981 c.c. of 25 per cent brine to supply 292.5 g. of salt for 100 g. NaOH. In the original equation with the saturating system only 750 c.c. of brine would be supplied; the remaining salt would be added in the solid state to the saturating vault to be dissolved in the slightly depleted anode circulation.

#### EFFECT OF DISSOLVED CHLORINE

Now turning to our chart relative to the solubility of chlorine in brine we find that 1,000 c.c. of 21 per cent brine will dissolve 280 c.c. chlorine (760 mm.) = 0.8876 g. This, in turn, corresponds to 1 g. NaOH. Hence 981 c.c. would carry chlorine = 0.981 g. NaOH to the cathode compartment, thus reducing the product or efficiency by practically 1 per cent (the greater the feed of brine—viz., the lower the decomposition with a given brine—the greater the loss). Also 1,000 c.c. 25 per cent brine will dissolve 170 c.c. chlorine at 60 deg. = 0.539 g. = 0.60 g. NaOH; hence 750 c.c. = 0.45 g. lost NaOH = 0.45 per cent drop in efficiency; hence we are better off by fully  $\frac{1}{2}$  per cent in efficiency by maintaining saturation. These chlorine losses are also shown on chart 7 relative to efficiency.

#### CHEMICAL EFFICIENCY

There is another and much more vital factor in efficiency that this form of chart, which I believe is

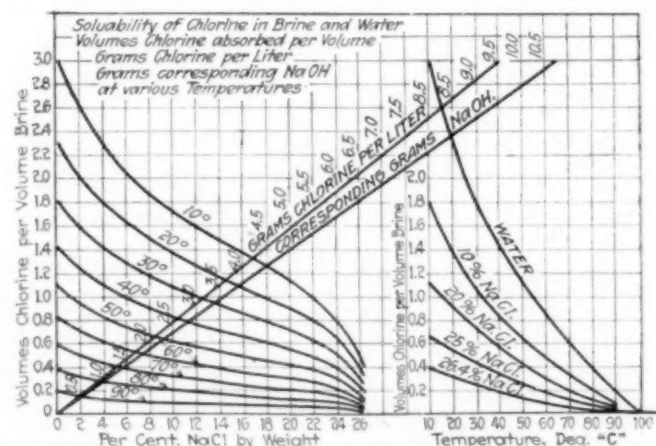


CHART 6. SOLUBILITY OF CHLORINE IN BRINE AND WATER

rather unique, permits of bringing out, and which permits of a very rational comparison of different cell performances—a study of diaphragm and general structural difficulties.

It is well known that over the ordinary working range of commercial operations with the same feed brine an increase in concentration of cathode caustic results in a decrease in efficiency, other conditions being equal. (At extreme dilutions this curve reverses, owing to the solubility of chlorine in brine.) I have sometimes used as an entirely empirical formula from the observation of 33½ per cent decomposition—viz., 292.5 NaCl per 100 NaOH, 98 per cent ampere efficiency; 50 per cent decomposition—viz., 146.25 NaCl per 100 NaOH, 96 per cent ampere efficiency; 60 per cent decomposition—viz., 97.50 NaCl per 100 NaOH, 88 per cent ampere efficiency.

We must calculate our loss of absorbed chlorine separately as previously shown by the volume and strength of brine within the cell and the operating temperature. For example, an experimental cell operating at 20-30 deg. will have a much greater chlorine loss than a large cell maintained at a high temperature.

Taking all these factors into consideration our curves indicate an ideal efficiency of, say, 95 per cent with 60 per cent decomposition (a result I never have obtained), 97-97.5 per cent at 50 per cent decomposition and 97.5-98 per cent at 40 per cent decomposition. The intermediate curves point to commercial results of various

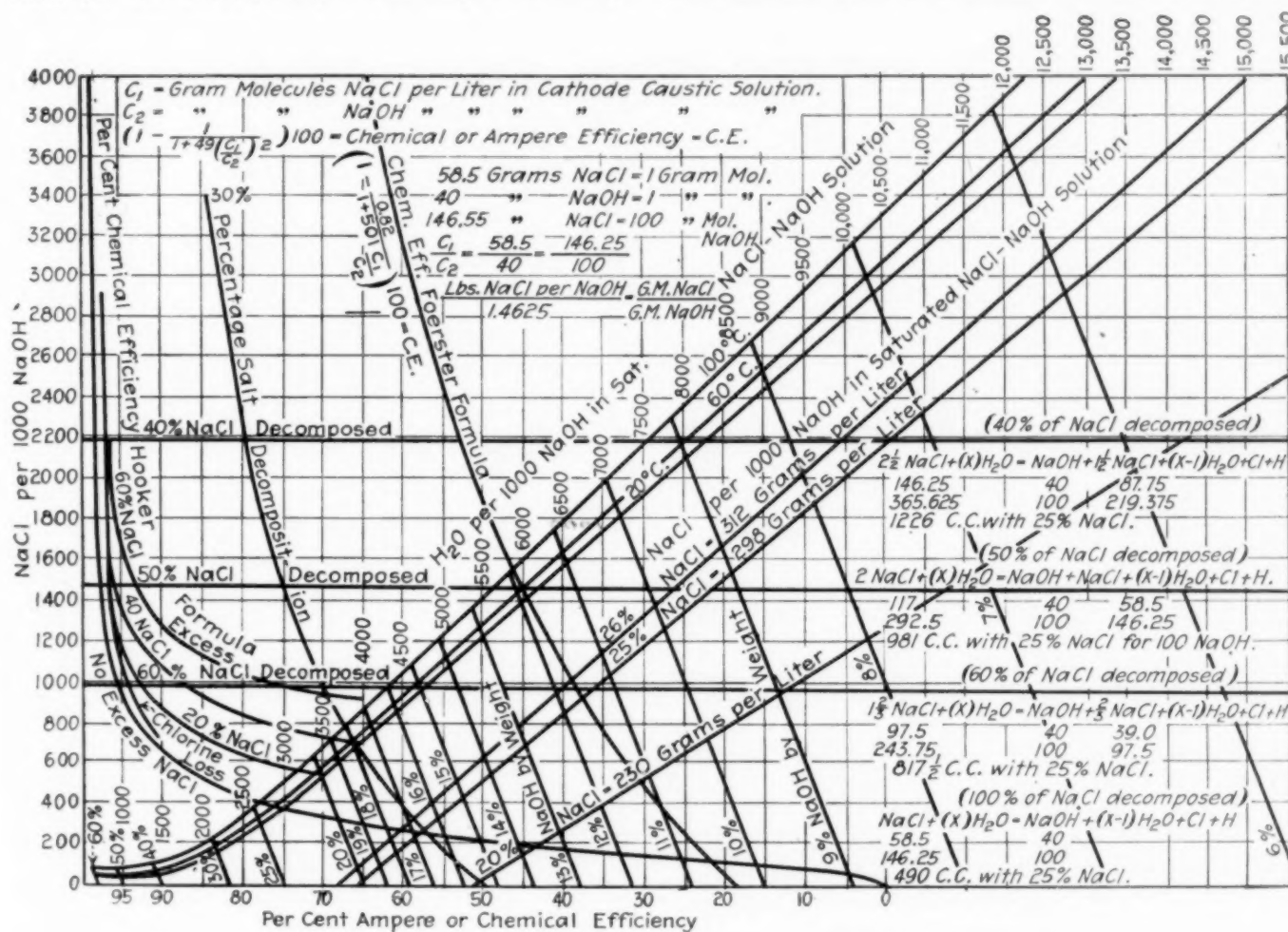


CHART 7. WATER AND SALT RATIOS TO NaOH. CHEMICAL EFFICIENCIES

This, however, contains two variables working in opposite directions—viz., increase in inefficiency, due to increase in salt ratio, and decrease in efficiency, due to increase in volume of brine with dissolved chlorine as a loss. Hence I submit the following formula for chemical or ampere efficiency, with a perfect diaphragm and uniform percolation over its entire surface (this, of course, is only an approachable ideal):

$C_1$  = gram molecules NaCl in effluent cathode caustic  
 $C_2$  = gram molecules NaOH in effluent cathode caustic

$$\left(1 - \frac{1}{1 + 49 \left(\frac{c_1}{c_2}\right)^2}\right) 100 = \text{chemical efficiency}$$

<sup>10</sup> Different decomposition  $60/40 = c_1/c_2 = 3/2 \cdot (3/2)^2 = 9/4 = 2.25$ , hence

$$\left(1 - \frac{1}{1 + 49 \left(\frac{\text{Cl}}{\text{C}_2}\right)^2}\right) 100 = 99.1 \text{ chemical efficiency}$$

<sup>11</sup> per cent decomposition  $50/40 = c_1/c_2 = 1/1 \ (1/1)^2 = 1$ , hence 98 per cent chemical efficiency.

0 per cent decomposition  $40/60 = c_1/c_2 = 2/3$   $(2/3)^2 = 4/9$ , hence 95.6 per cent chemical efficiency.

types and imply a mixed decomposition at various parts of the cell.

If we assume that for 100 g. of NaOH produced in unit time we feed 292.5 g. of NaCl—146.25 g. are decomposed and 146.25 g. remain with the effluent caustic at 50 per cent decomposition. This should result 97-97.5 per cent amp. efficiency according to whether we figure on a 25 per cent brine feed or saturation of the cathode caustic. Now suppose we find only 95 per cent amp. efficiency corresponding to 60 per cent decomposition, or 97.5 lb. NaCl per 100 NaOH; this means that  $146.25 - 97.5 = 48.75$  NaCl per 100 NaOH has passed through the diaphragm to the cathode caustic performing no really useful purpose. This would mean 194 lb. of 25 per cent excess brine to handle for every 100 lb. NaOH produced. There are many commercial cases far worse than this that could be cited. Probably no original diaphragm is at its best until a true "Schmutz Decke," as the water filtration people say, is formed.



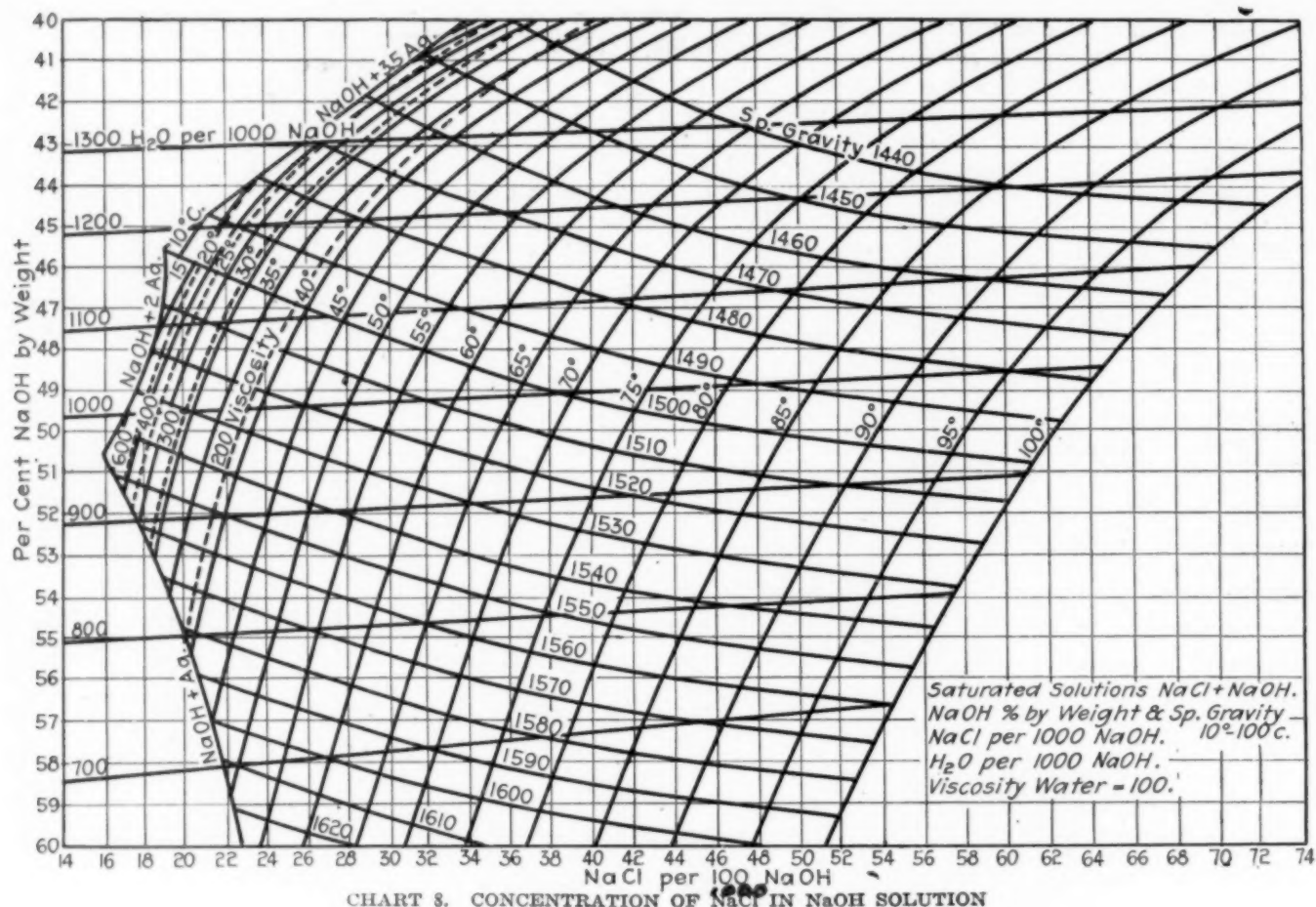


CHART 8. CONCENTRATION OF NaCl IN NaOH SOLUTION

and certainly it makes a material difference whether there is a varied flow and consequently varied decomposition at different heights of the same cell. I offer these provisional curves as a new basis for study in cell efficiency and performance.

Another useful function of chart 7 will, I think, appeal to Hugh K. Moore. I refer particularly to its use in connection with caustic evaporator problems such as he so ably described at the St. Louis meeting in 1917. This chart permits of following directly any caustic solution at any temperature from start to finish through the vacuum pans if we start with the product of 50 per cent decomposition and 25 per cent brine having a composition of 1,000 NaOH, 1,462 NaCl, 8,325 H<sub>2</sub>O. We concentrate until we reach 1,000 NaOH, 1,462 NaCl, 5,600 H<sub>2</sub>O—loss 2,725 lb. H<sub>2</sub>O—before any salt separates out. After this there is a constant removal of salt and water in the proportion of about 2,800 lb. water per 1,000 lb. salt until we reach about 30 per cent NaOH by weight. Here the rate of salt to water changes, although we now have only 200 lb. salt left from our original 1,462 lb. per 1,000 NaOH.

#### DATA ON CONCENTRATED CATHODE LIQUOR

At about 50 per cent concentration we have approximately 60 lb. salt left for 1,000 NaOH and this cannot be materially reduced (as will be seen by the abrupt turn of the curve) by further concentration in the evaporators. However, commercial grades of finished caustic require a material reduction beyond this point. A glance at the curve shows that nearly two-thirds of the salt present at this stage at 100 deg. can be removed by cooling to 20 deg. As this is a somewhat critical operation, it becomes desirable to magnify the small fraction of our curve between 40 per cent NaOH and 60

per cent NaOH. I prepared an interesting curve on this order in 1911. I believe Mr. Barton of the Berlin Mills has a copy which I gave him. I am not sure that any other copies were given out. I know that Mr. Mantius of the Zaremba Co. used one of our copies on our work. This chart was quite complete, as you will see by the blueprint which I am circulating, and contained, in addition to the figures on chart 9 which I am showing, the resulting analysis from finishing certain grades of caustic liquor. I have purposely left these figures from the present chart, which is materially corrected to correspond to more recent results which have gradually accumulated showing some variation from the original. While it is true that lines can be introduced showing the finished grade, these will depend upon individual plant practice, partly as regards sulphate and carbonate, but particularly as to chlorate in the final liquors, hence are not constant. The figures for viscosity I prefer to use, not as I did on the old chart, but in a final chart which I will introduce.

#### RELATIVE PERCENTAGES OF CAUSTIC AND SALT

This chart 9 shows per cent NaOH by weight and per cent NaCl by weight, also specific gravity and pounds water per pound NaCl. It should be borne in mind that in cooling a saturated solution of salt and caustic the caustic water ratio remains constant while the salt ratio varies. Hence if we start at, say, 100 deg. with 1,000 NaOH, or 51 per cent NaOH, 900 H<sub>2</sub>O, and 3.1 per cent NaCl, and cool to, say, 40 deg. we will still have 1,000 NaOH, but with 52 per cent NaOH, 900 H<sub>2</sub>O and 1.18 per cent NaCl.

While this chart gives all the necessary information, I much prefer to use this information in the form shown in chart 8, which, I believe, is quite original in



CATHODE LIQUOR TABLES

20 Deg. C.										60 Deg. C.									
Per Cent NaOH by Weight	Per Cent NaCl by Weight	Per Cent H <sub>2</sub> O by Weight	Sp. G. 20°/4°	G. NaOH per Liter	G. NaCl per Liter	G. H <sub>2</sub> O per Liter	NaCl per 100 NaOH	H <sub>2</sub> O per 100 NaOH		Per Cent NaOH by Weight	Per Cent NaCl by Weight	Per Cent H <sub>2</sub> O by Weight	Sp. G. 60°/-	G. NaOH per Liter	G. NaCl per Liter	G. H <sub>2</sub> O per Liter	NaCl per 100 NaOH	H <sub>2</sub> O per 100 NaOH	
0	26.4	73.6	1204		313	886				0	27.0	73	1187		320.49	866.51			
2	24.73	75.27	1211.5	24.23	299.6	887.67	1236.48	3663.22		2	25.3	72.7	1194.75	23.90	301.26	869.59	1260.50	3635.0	
4	23.05	72.95	1219.5	48.78	281.09	889.63	576.24	1823.76		4	23.61	72.39	1202.5	48.10	283.91	870.49	590.24	1809.75	
6	21.3	72.7	1228	73.64	261.56	892.76	354.96	1211.67		6	21.94	72.06	1210.5	72.63	265.58	871.29	365.66	1201	
8	19.6	72.4	1237	98.96	242.45	895.59	244.99	904.80		8	20.27	71.73	1219	97.52	247.09	874.39	253.37	896.62	
10	18.05	71.95	1245.5	124.55	224.8	896.1	179.7	719.5		10	18.7	71.3	1228	122.80	229.64	875.56	187.00	712.91	
12	16.5	71.5	1255	150.6	207.08	897.3	137.5	595.8		12	17.13	70.87	1237	148.44	211.90	876.66	142.75	590.59	
14	14.98	71.02	1265	177.1	189.5	898.4	107	507.3		14	15.61	70.39	1246.5	174.51	194.58	877.41	111.49	503.07	
16	13.45	70.55	1275	204	171.5	899.5	84.1	440.9		16	14.09	69.91	1256	200.96	176.97	878.07	88.06	437.43	
18	11.9	70.1	1285.5	231.39	152.97	901.14	66.7	393.7		18	12.6	69.4	1266	227.88	159.52	878.6	70.0	385.77	
20	10.45	69.55	1296	259.2	135.4	901.4	52.2	347.7		20	11.11	68.89	1277	255.4	141.87	879.73	55.54	344.45	
22	9.05	68.95	1307.25	287.60	118.31	901.1	41.1	313.3		22	9.76	68.24	1287.5	283.25	124.46	879.79	44.4	310.60	
24	7.75	68.25	1318.5	316.44	102.2	899.9	32.3	286.2		24	8.42	67.58	1299	311.76	109.37	877.87	35.08	281.58	
26	6.5	67.5	1331	346.06	86.5	898.4	25	259.6		26	7.20	66.88	1312	341.12	94.46	876.42	27.39	256.89	
28	5.3	66.7	1343.5	376.18	76.5	895.1	19.0	237.9		28	5.98	66.02	1325	372	79.24	873.76	21.30	234.67	
30	4.29	65.71	1358.25	407.48	58.27	892.5	14.3	219		30	4.97	65.03	1338	401.4	66.5	870.1	16.56	217.26	
32	3.27	64.73	1373	439.36	44.9	888.74	10.2	202.1		32	3.97	64.03	1352.5	432.8	53.69	866.01	12.40	200.09	
34	2.6	63.4	1389	472.26	36.1	880.64	7.6	186.5		34	3.37	62.63	1367.5	464.95	46.08	856.47	9.91	184.20	
36	2.07	61.93	1405	505.80	29.1	870.1	5.7	172.2		36	2.77	61.23	1384	498.24	38.34	847.42	7.51	170.08	
38	1.75	60.25	1422.5	540.5	24.9	857.1	4.6	158.5		38	2.46	59.54	1401	532.38	34.46	834.16	6.47	156.68	
40	1.44	58.56	1440	576	20.7	843.3	3.6	146.5		40	2.15	57.85	1419	567.60	30.51	820.89	5.37	144.45	
42	1.26	56.74	1460	613.2	18.40	828.4	3.0	135		42	1.98	56.02	1437.5	603.75	28.46	805.29	4.71	133.38	
44	1.09	54.91	1480	651.2	16.1	812.7	2.4	124.8		44	1.81	54.19	1457	641.08	26.37	789.55	4.11	123.16	
46	1.01	52.99	1499.5	689.8	15.1	794.6	2.1	115.2		46	1.74	52.26	1476.25	679.07	25.69	771.49	3.77	113.60	
48	0.94	51.06	1519	731.1	14.3	773.6	1.9	105.8		48	1.67	50.33	1496	718.08	24.98	752.94	3.48	104.85	
50	0.91	49.09	1538	769	13.9	755.1	1.8	98.2		50	1.61	48.36	1516	758	24.86	733.14	3.28	96.72	
52	0.89	47.11	1559	810.68	13.9	734.42	1.7	90.59		52	1.61	46.39	1536.25	798.85	24.86	712.54	3.11	89.19	
54	0.87	45.13	1580.5	853.47	13.9	713.13	1.6	82.38		54	1.59	44.41	1557	839.78	24.86	692.36	2.96	82.44	
56	0.86	43.14	1603	897.68	13.9	691.42	1.55	77.01		56	1.57	42.43	1578.5	883.96	24.86	669.68	2.81	75.75	
58	0.85	41.15	1625.5	942.79	13.9	668.81	1.47	70.94		58	1.55	40.45	1601	928.58	24.86	647.56	2.66	69.73	
60	0.84	39.16	1649	989.4	13.9	645.7	1.40	65.26		60	1.53	38.47	1624.5	947.70	24.86	614.94	2.55	63.11	

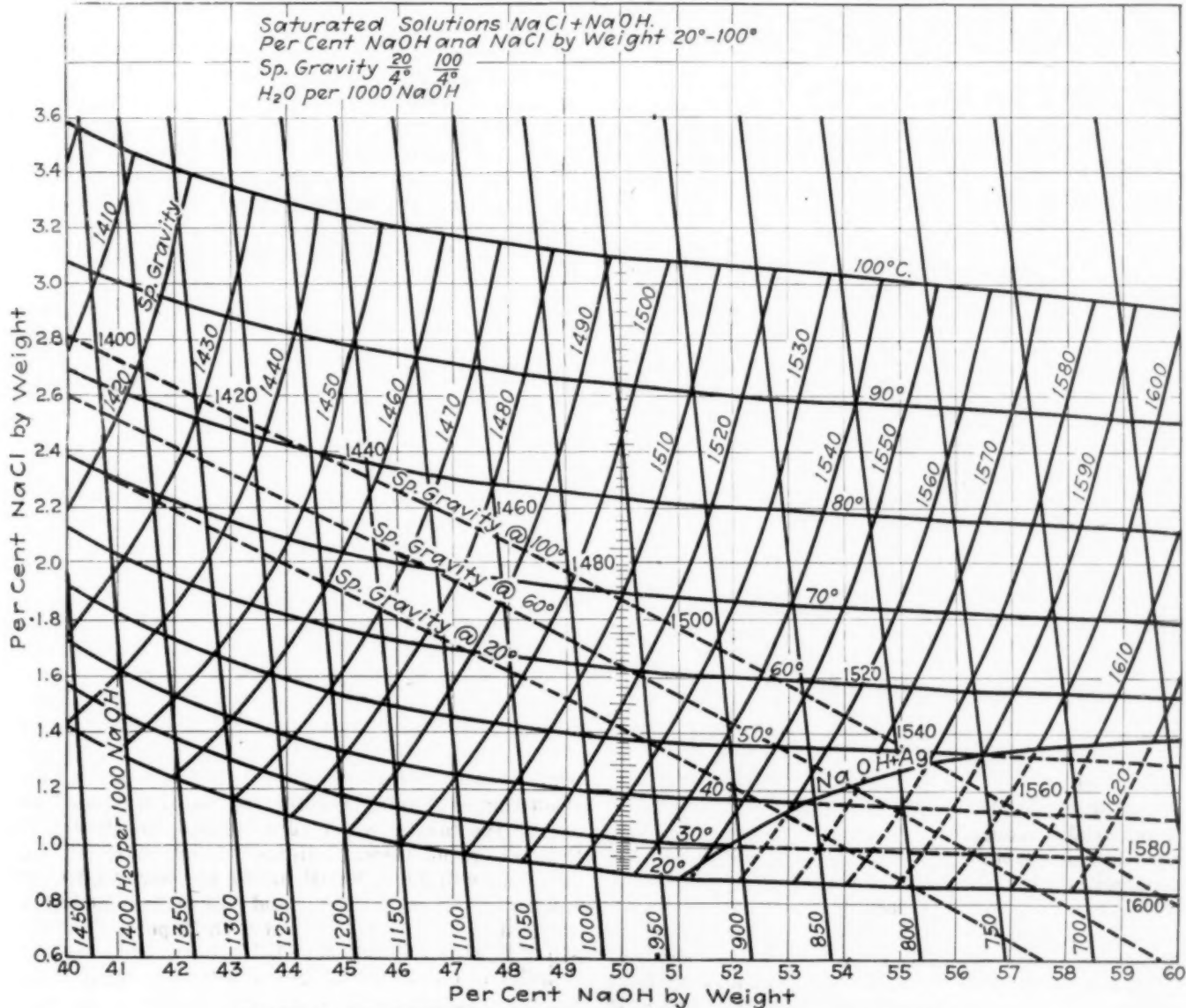


CHART 9. PERCENTAGE OF NaCl AND NaOH DURING CONCENTRATION

CATHODE LIQUOR TABLES—(Continued)

100 Deg. C.									
Per Cent NaOH by Weight	Per Cent NaCl by Weight	Per Cent H <sub>2</sub> O by Weight	Sp. G. 100°	G. NaOH per Liter	G. NaCl per Liter	G. H <sub>2</sub> O per Liter	NaCl per 100 NaOH	H <sub>2</sub> O per 100 NaOH	
0	28.2	71.8	1170		329.94	840.16			
2	26.54	71.46	1177.5	23.55	312.50	841.45	1326.97	3572.82	
4	24.88	71.12	1185	47.40	295.73	843.87	622.0	1778	
6	23.20	70.80	1193	71.58	276.78	844.64	386.5	1180	
8	21.52	70.48	1201.5	95.12	258.55	845.82	258.99	881.00	
10	19.96	70.04	1210.5	121.05	241.62	847.83	199.59	700.39	
12	18.4	69.6	1219.5	146.34	224.39	847.79	154.85	580.00	
14	16.89	69.11	1229	172.05	207.08	849.25	120.70	493.50	
16	15.38	68.62	1238.5	198.16	190.48	849.85	95.12	428.82	
18	13.90	68.10	1248.5	224.73	173.54	850.23	77.22	378.33	
20	12.42	67.58	1259	251.8	155.37	850.83	62.10	337.90	
22	11.08	66.92	1269	279.18	140.60	849.22	50.35	304.18	
24	9.75	66.25	1280.5	307.32	124.85	848.33	40.62	276.04	
26	8.54	65.46	1292.5	335.05	110.38	846.07	32.84	251.70	
28	7.33	64.64	1305	365.40	95.6	843.94	26.18	230.93	
30	6.34	63.66	1318.5	395.55	83.59	839.36	21.13	212.20	
32	5.35	62.65	1332	425.24	71.26	834.50	16.71	195.78	
34	4.76	61.24	1347	457.98	64.11	824.91	14.00	180.11	
36	4.17	59.83	1363	490.68	56.85	815.47	11.59	166.19	
38	3.87	58.13	1380	524.40	53.41	802.19	10.18	152.09	
40	3.57	56.43	1398	559.20	49.91	788.89	8.92	141.25	
42	3.41	54.59	1417	595.14	48.32	773.54	8.12	129.97	
44	3.26	52.74	1435.5	631.62	46.80	757.08	7.40	119.86	
46	3.20	50.80	1454	668.84	46.53	738.63	6.95	110.43	
48	3.14	48.86	1473	706.04	46.25	720.71	6.55	102.07	
50	3.12	46.88	1493.5	746.75	46.60	700.15	6.24	93.76	
52	3.07	44.93	1513.5	787.02	46.60	679.88	5.90	86.38	
54	3.04	42.96	1534	828.36	46.60	659.04	5.62	79.50	
56	2.99	41.11	1555	870.80	46.60	637.60	5.35	73.22	
58	2.95	39.05	1576.5	914.37	46.60	615.53	5.09	67.31	
60	2.91	37.09	1600	960.00	46.60	593.40	4.85	61.81	

its arrangement, yet makes a most convenient form for arriving at the desired results in finishing caustic. If we start with a 51 per cent solution of caustic, this at 100 deg. will have a specific gravity of 1.503 and 1,000 lb. NaOH, 900 lb. H<sub>2</sub>O, 62 lb. NaCl; cooling to 40 deg. C., we have practically 52 per cent caustic by weight, 1,000 lb. NaOH, 900 lb. H<sub>2</sub>O, 22 lb. NaCl, specific gravity 1.550.

Our viscosity, which plays a very important part in the final time of settling of salt, is now practically 200 compared to water as 100. By still further cooling to 25 deg. C. we have a specific gravity of 1.560, a solution containing 1,000 NaOH, 900 H<sub>2</sub>O, 18 NaCl, but our viscosity has reached nearly 400, making it practically impossible to settle out this last 4 lb. of salt. Also we are at the point of freezing or solidification for part of our solution, hence have passed the limits with this particular solution.

It is quite obvious that clear across this chart with 20 to 25 or 30 lb. of salt the same grade of finished caustic will result and could be plotted out. To this salt must be added the salt from decomposing chlorates, which varies with different plant operations. We have now passed from a cell liquor containing 1,000 lb. NaOH, 8,325 lb. H<sub>2</sub>O, 1,462 lb. NaCl, to a solution containing 1,000 NaOH, 900 H<sub>2</sub>O, 22 NaCl, and I think can safely leave the final finishing in the pots for another story.

### Production of Leather From Rabbit Skins

Consul Norton writes from Sydney, Australia, that a secret process, said to be unknown hitherto to the tannery trade, has been discovered by an Australian for making leather from rabbit skins and recovering the fur as a byproduct for felt making. A company has been formed in Sydney to turn this discovery to practical use, having established works capable of handling about 100,000 skins a week. The leather has already been utilized in Sydney in the manufacture of boot and shoe uppers, hand bags, gloves and other articles.

### Sugar Production in Mauritius

One of the unusual results of the recent situation in the American sugar market is the bringing of cane sugar to the United States from the small British island of Mauritius, off the east coast of Africa, says *Commerce Monthly*.

The share of Mauritius in the total sugar supply is not large, as the usual crop averages less than 2 per cent of the world's annual production. The output of about 240,000 metric tons annually represents the product of a highly concentrated industry carried on in one of the most densely populated regions of the world. With an area of 720 square miles, less than one-sixtieth of that of Cuba, the island devotes 176,000 acres to sugar plantations, or about one-eighth of the acreage in Cuba, recently reported as 1,385,000. The sugar crop of Mauritius for the past three years has averaged about

TABLE I. PRODUCTION OF SUGAR IN MAURITIUS  
(In thousands of metric tons)

1912-13	213	1917-18	226
1913-14	250	1918-19	273
1914-15	277	1919-20	235
1915-16	215	1920-21	40
1916-17	209	* Estimate.	

6 per cent of the Cuban crop. Production for the years from 1913 to date is shown in Table I.

Practically the entire crop is exported, as less than 10,000 tons a year is reserved for local consumption. As a rule the value of the sugar exported is more than sufficient to pay for the total imports received. Sugar accounts for 90 to 95 per cent of the exports, and molasses and rum are relatively large items in the balance.

During the war and the two following years the British Royal Commission on the Sugar Supply purchased the bulk of the Mauritius sugar and it is stated that the quantity contracted for in 1920 amounts to 200,000 tons.

TABLE II. SUGAR TRADE OF MAURITIUS\*  
(In thousands of metric tons)

	Total Exports	Imports Into United Kingdom	Imports Into British India
1909-13 (average)	205	38	139
1914	289	71	145
1915	226	195	87
1916	231	110	71
1917	191	52	26
1918	1197	100	33
1919	1260	181	78
1920	1221	104	24

\*Total exports and imports into United Kingdom are for the calendar year, while imports into British India are for the year ended March 31.

†Eleven months ended July 4.

‡Ten months ended May 14.

§First eight months.

Total exports of sugar from Mauritius and the amounts imported into the United Kingdom and British India from 1909 to date are shown in Table II.

The industry is carried on largely by French and Indian planters, the latter cultivating as much as 40 per cent of the total area in sugar cane. A syndicate represents the interests of the planters and it may later supervise purchases of machinery and other supplies. The development of the industry in the island has reached a flourishing state. Part of the cane area is irrigated and the fifty-nine sugar estates operate light railway systems to carry cane to the mills. Modern crystallizers and centrifugals are in use and there is an active interest in labor-saving machinery. It has been suggested that American manufacturers might find a market in Mauritius for sugar mill machinery, rails and tramway supplies.



## Steel Rails From Sink-Head and Ordinary Rail Ingots—II

A Detailed Statement of the Disposition of the Metal From Ingots Used in This Test, as Demanded by Its Mechanical and Chemical Characteristics—Sink-Head Ingots Are Shown to Give Much More Uniform Metal Than Common American Types\*

By GEORGE K. BURGESS†

### SINK-HEAD INGOTS

**D**UE to the uncertainty of the location of the sink-head junction, an arbitrary allowance has to be made in advance at hot saw or shears, or one risks having the A rails rejected. If the total top discard (bloom and rail) is adjusted to 13 per cent there will be no rails rejected on account of sink-head; if this is set at 8 per cent one would expect about one-half the A rails to contain surface imperfections caused by the sink-head and ingot junction. The sink-head alone entails on the average a discard of about 9.1 per cent of the Hadfield ingot, as is shown in Table VI.

The ingot usually enters the rolls with large end and sink-head first; there appears, however, to be no difference which end of ingot is first subjected to the "squaring up" pass. The presence of the sink-head appears to present no difficulties in either the blooming mill or rail mill. One ingot cracked at the bottom of the sink-head during rolling, but this was without effect on the passage of this bloom through the rolls.

Two of the thirty-five sink-head ingots (Nos. 18 and 4) examined as rails had pipes, detected in the mill, extending into the ingot 10 or 11 per cent, or to about 5 per cent below the sink-head in some cases (Table VI). All piping would appear to be eliminated with a discard of 11 per cent, which turns out to be very nearly that required to eliminate all sink-head imperfections and carbon segregation above 12 per cent (Table X).

### COMPARISON INGOTS

As already noted, there were fifteen Maryland ingots in three groups of five each, of about 7,300 lb. each, top poured into ingot molds with small end up. They were rolled as portions of three heats on different dates, the total number of ingots in a heat being thirteen or twenty. The time of teeming into molds was about 35 sec. each and the temperatures are as shown in Table VII. The product from each heat thus forms a distinctive group and should be considered separately. The ingots were selected arbitrarily before being cast, it being agreed that five ingots would be taken and they were to be poured in succession after the second one of the heat. The heats were three of a series of rail steel from the ordinary output of the open hearth.

The first ten ingots, heats 2x4497 (ingots M1 to M5) and 1x3632 (ingots M6 to M10) were apparently made from rising steel, while ingots M1 to M15 of heat 2x4510 were from quiet or "killed" steel; ingots M6 to M15 were deoxidized with aluminum; ingots M1 to M10 were chilled on top, M1 to M5 with cast-iron caps, and M6 to M10 with water.

The effects of these differences in furnace and casting practice are very striking on the finished product. Thus the deoxidized flat-top ingots M11 to M15 show, as would be expected, pronounced piping; for this group, the average discard to physically sound steel is 26.5 per cent (Table VI) and ranging from 8.5 to 39.5 per cent. With this discard may be compared the discard of 5.2 per cent for the first Maryland group and 8.0 per cent for the second, and, except in two cases out of thirty-five, a negligible discard for piping below the sink-head of the Hadfield ingots (Table VI). The small discard (6.6 per cent) to sound steel for the average of the first two Maryland groups is, however, misleading, as there may exist internal or enclosed pipes—especially in the second or deoxidized group. In the first comparison group (ingots M1 to M5) one would ex-

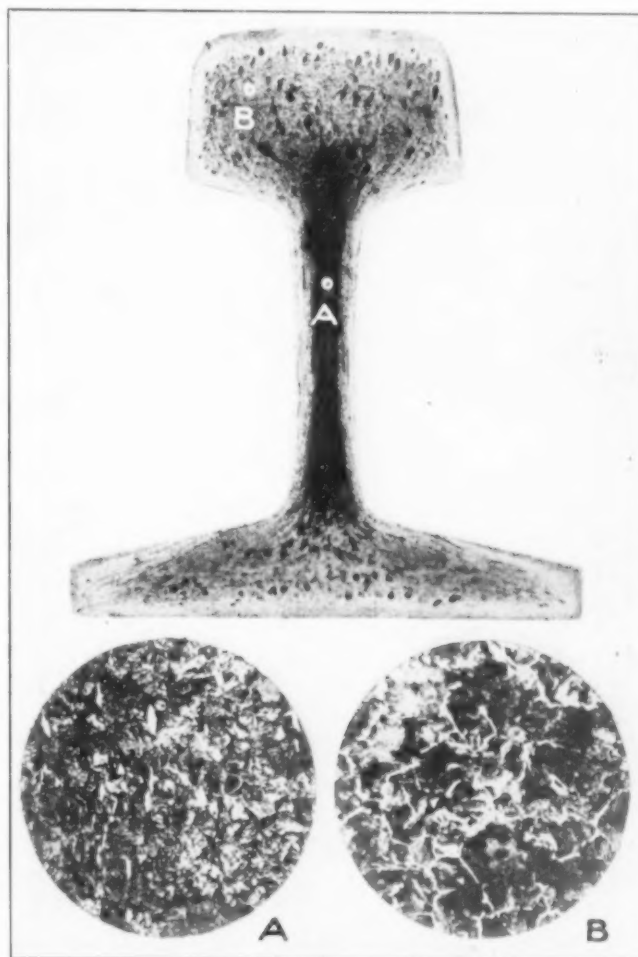


FIG. 3. RAIL M1-A

Sulphur print shows extreme segregation from top of ingot.  
A—Moderately fine grained hyper-eutectoid segregation, pearlite with a trace of cementite and many small slag inclusions.  
B—Moderately fine grained hypo-eutectoid structure, pearlite with a thick irregular ferrite network.

\*For Part I see CHEM. & MET. ENG., vol. 23, No. 19, Nov. 10, 1920, p. 921.

†Chief division of metallurgy, Bureau of Standards.





TABLE VII. POURING TEMPERATURES OF COMPARISON INGOTS

Ingot No.	Heat 2x4510 Temp., Deg. C.	Ingot No.	Heat 2x4510 Temp., Deg. C.
M6	1,596	M11	1,545
M7	1,587	M12	1,538
M8	1,564	M13	1,540
M9		M14	1,528
M10	1,578	M15	1,531
Average	1,581	Average	1,536

pect to find a spongy segregated structure in the upper part of ingot. This is brought out in some of the sulphur prints of rail from the upper part of the ingots of this group, a typical one being shown in Fig. 3.

Of the first group, M5 contains a very pronounced pipe near the bottom of the ingot in the F position (Fig. 6). The question may be raised as to whether the practice of chilling the ingot top does not tend to produce internal pipes which may be distributed anywhere along the center line of the ingot.

The phenomenon of segregation, which is intimately allied to the furnace and casting practice for the Maryland ingots, is discussed separately. The mechanical properties, as brought out by the several tests, ultimate strength, yield point, elongation, reduction of area, hardness and drop test, show less dependence on the processes of manufacture, as will be brought out later.

TABLE IX. CARBON SEGREGATION IN RAILS FROM SINK-HEAD INGOTS

Ingot	Rail A Per Cent	Rail B Per Cent	Rail C Per Cent	Rail D Per Cent	Rail E Per Cent
H1	13.02	-0.15	-3.75	-4.59	1.23
H2	9.44	0.00	-2.67	-6.77	-1.60
H3	11.65	5.53	-3.89	-7.42	-0.79
H4	16.49	4.83	-3.82	-3.41	-0.62
H5			-1.29	-1.30	-0.44
H6	9.25	4.86	-1.73	-6.40	2.78
H7	19.79	0.30	-1.95	-0.15	-0.60
H8	3.34	1.68	-0.15	-5.20	1.57
H9	23.77	4.87	-1.12	-6.20	-0.34
H10	20.63	2.17	0.31	-4.54	3.09
H11	4.69	3.74	0.32	-5.16	0.32
H12	2.16	1.44	-2.41	-6.52	-0.57
H13	46.69	-3.11	-4.35	-1.27	-2.79
H14	2.48	1.49	0.00	-4.32	0.30
H15	7.83	4.08	-4.63	1.18	1.63
H16	13.93	4.52	-2.33	-9.74	-1.41
H17	1.50	4.75	1.22	-5.33	3.29
H18	5.20	1.96	-0.30	-3.46	2.14
H19	9.66	2.85	0.00	-7.28	0.81
H20	1.04	2.60	-1.96	-5.07	1.73
H21	11.91	1.66	-0.75	0.45	2.61
H22	2.67	-0.75	0.31	-3.48	-0.30
H23	24.35	0.77	-1.69	-4.09	-1.42
H24	21.94	-2.26	-2.88	-2.93	-4.55
H25	5.17	2.68	1.52	-2.56	2.73
H26	34.16	0.60	-1.22	-7.11	0.92
H27	4.76	1.38	0.00	-4.48	3.09
H28	26.77	2.97	-3.12	-5.43	0.16
H29	10.50	3.58	-1.72	-7.55	0.49
H30	15.57	2.54	-0.47	-4.38	-0.97
H31	12.89	2.95	0.31	-3.70	0.62
H32	3.83	2.06	-7.41	-2.68	0.60
H33	10.11	6.75	-2.72	-5.16	-2.96
H34	10.33	3.32	-5.11	-6.16	1.46
H35	15.48	2.37	2.54	-4.59	-0.96
Average	+12.73	+2.32	-1.27	-4.48	+0.40
Average deviation from mean	±7.48	±1.35	±1.68	±1.81	±1.42

TABLE VIII. MECHANICAL AND CHEMICAL CHARACTERISTICS OF RAILS

Rail No.		Mechanical Tests				Chemical Tests			Sulphur	
		Yield Point	Ultimate	Elongation	Reduction	Brinell Hardness	"O" %	"M" %	"O" %	"M" %
H-A	Average = A <sub>A</sub>	62,074	125,986	14.5	23.48	259	0.652	0.733	0.047	0.050
	Δ	1,585	2,342	0.7	1.25	6	0.018	0.044	0.003	0.005
H-B	Average = A <sub>B</sub>	63,212	126,381	13.3	23.89	264	0.649	0.664	0.047	0.048
	Δ	1,206	2,027	0.9	1.50	8	0.016	0.018	0.004	0.005
	A <sub>B</sub> - A <sub>A</sub>	+1,138	+395	-1.2	+0.41	+5	-0.003	-0.069	0.0	-0.002
H-C	Average = A <sub>C</sub>	62,941	126,054	13.6	24.30	260	0.653	0.644	0.047	0.046
	Δ	1,109	2,130	0.7	1.18	9	0.017	0.017	0.003	0.003
	A <sub>C</sub> - A <sub>A</sub>	+867	+68	-0.9	+0.82	1	+0.001	-0.089	0.0	-0.004
H-D	Average = A <sub>D</sub>	63,029	126,158	13.6	24.47	260	0.650	0.621	0.047	0.044
	Δ	1,310	2,381	0.7	1.14	7	0.017	0.022	0.004	0.004
	A <sub>D</sub> - A <sub>A</sub>	+955	+172	-0.9	+0.99	+1	-0.002	-0.112	0.0	-0.006
H-E	Average = A <sub>E</sub>	62,264	124,303	14.2	25.70	256	0.637	0.639	0.046	0.046
	Δ	1,418	2,900	0.8	1.63	10	0.019	0.023	0.004	0.004
	A <sub>E</sub> - A <sub>A</sub>	+190	-1,683	-0.3	+2.22	-3	-0.015	-0.094	-0.001	-0.004
All Hadfield rails	Average	62,704	125,771	13.8	24.38	260	0.648	0.660	0.047	0.047
	Δ	1,326	2,356	0.8	1.34	8	0.017	0.025	0.004	0.005
M-A	Average = A <sub>A</sub>	62,063	124,834	13.2	22.76	255	0.644	0.735	0.091	0.106
	Δ	2,091	3,472	0.6	2.14	11	0.064	0.048	0.005	0.020
M-B	Average = A <sub>B</sub>	63,979	128,786	11.9	21.73	260	0.665	0.697	0.099	0.110
	Δ	840	1,488	0.5	1.19	4	0.031	0.109	0.002	0.008
	A <sub>B</sub> - A <sub>A</sub>	+1,916	+3,952	-1.3	-1.03	+5	+0.021	-0.038	+0.008	+0.004
M-C	Average = A <sub>C</sub>	62,050	126,220	13.5	23.92	251	0.660	0.644	0.098	0.096
	Δ	631	1,606	0.6	0.61	6	0.029	0.034	0.001	0.002
	A <sub>C</sub> - A <sub>A</sub>	-13	+1,388	+0.3	+1.16	-4	+0.016	-0.091	+0.007	-0.010
M-D	Average = A <sub>D</sub>	61,567	125,248	13.1	25.80	248	0.660	0.612	0.099	0.090
	Δ	999	1,495	0.6	0.72	4	0.031	0.032	0.002	0.006
	A <sub>D</sub> - A <sub>A</sub>	-496	+414	-0.1	+3.04	-7	+0.016	-0.123	+0.008	-0.013
M-E	Average = A <sub>E</sub>	59,726	122,523	14.3	28.79	243	0.638	0.573	0.095	0.082
	Δ	1,068	1,535	0.5	1.09	5	0.043	0.044	0.002	0.002
	A <sub>E</sub> - A <sub>A</sub>	-2,337	-2,311	+1.1	+6.03	-12	-0.006	-0.162	+0.004	-0.024
M-F	Average = A <sub>F</sub>	58,826	119,663	15.5	31.68	242	0.611	0.616	0.088	0.091
	Δ	1,052	2,049	0.5	0.71	8	0.017	0.040	0.002	0.003
	A <sub>F</sub> - A <sub>A</sub>	-3,237	-5,179	+2.3	+8.92	-13	-0.033	-0.119	-0.003	-0.015
All Maryland rails	Average	61,368	124,545	13.6	25.78	250	0.645	0.646	0.095	0.096
	Δ	1,113	1,941	0.6	1.01	6	0.036	0.051	0.002	0.006
M-1 to M-5	Average	60,783	122,352	13.5	26.26	245	0.620	0.631	0.071	0.076
	Δ	1,873	3,068	1.2	3.53	9	0.020	0.064	0.006	0.012
M-6 to M-10	Average	60,757	124,792	13.1	24.03	250	0.636	0.665	0.098	0.103
	Δ	1,416	2,151	1.2	3.13	6	0.024	0.038	0.004	0.010
M-11 to M-15	Average	62,431	126,258	13.8	27.17	255	0.661	0.641	0.116	0.114
	Δ	1,604	4,681	0.7	2.62	3	0.038	0.045	0.005	0.002

1 Δ denotes average deviation from mean.  
2 Near tread—i. e., in upper corner of head.

3 Top of web.  
4 Percentage of carbon variation in O and M analysis—i. e., (M - O) ÷ O.

TABLE X. CARBON SEGREGATION IN RAILS FROM COMPARISON INGOTS

Ingot	Rail A	Rail B	Rail C	Rail D	Rail E	Rail F
M1	30.88	7.17	8.80	5.07	12.34	13.45
M2	30.39	27.55	0.31	7.73	13.06	3.93
M3	13.30	9.63	0.96	5.79	15.20	4.44
M4	20.17	5.28	8.23	4.41	15.89	2.96
M5	16.85	3.37	1.25	7.61	15.24	10.75
M6	16.51	9.20	4.98	5.93	3.71	0.62
M7	19.34	5.07	3.68	3.44	8.79	0.00
M8	2.51	5.05	0.91	5.76	6.65	0.64
M9	9.15	5.38	0.73	8.27	1.42	5.91
M10			0.31	3.73	4.41	
M11	3.08	0.87	4.95	8.69	11.78	1.16
M12	32.52	1.61	3.61	11.00	11.68	2.08
M13		1.98	5.31	7.12	13.82	1.47
M14	4.74	6.26	2.48	11.92	8.62	0.16
M15	0.15	3.07	3.73	10.66	11.09	2.61
Average	+14.41	+5.00	-2.42	-7.14	-10.46	+0.27
deviation from mean	7.53	2.67	2.35	1.39	1.57	3.18

TABLE XI. DISCARDS IN RAILS FROM SINK-HEAD INGOTS

Ingot	A-rail Crop, Ft.	Cut for Segregation, Ft.	Top Discard, per Cent	For Soundness	Middle Discard, per Cent	Bottom Discard, per Cent	Total Discard for Soundness
H1	5	15	16.2	...	1.8	3.0	4.8
H2	5	10	12.3	...	1.8	2.5	4.3
H3	11	5	13.9	...	2.6	3.4	6.0
H4	5	15	17.5	...	1.8	3.4	5.2
H6	5	5	12.4	...	1.9	3.7	5.6
H7	5	10	14.0	...	2.1	3.7	5.8
H8	10	5	12.1	...	2.4	3.9	6.3
H9	5	10	15.0	...	2.3	4.2	6.5
H10	5	10	15.6	...	2.0	3.6	5.6
H11	8	5	14.3	...	2.1	3.7	5.8
H12	10	0		10.7	2.1	4.1	16.9
H13	5	10	13.0	...	1.8	3.8	5.6
H14	5	10	13.8	...	1.9	3.8	5.7
H15	5	10	12.6	...	2.2	3.3	5.5
H16	9	5	12.4	...	1.7	4.4	6.1
H17	10	0		9.1	2.4	4.0	15.5
H18	5	10	13.9	...	2.4	3.9	6.3
H19	9	5	11.8	...	1.9	3.6	5.5
H20	9	5	14.0	...	2.1	3.7	5.8
H21	5	5	14.6	...	2.3	3.6	5.9
H22	5	0	11.5	...	1.8	3.4	5.2
H23	8	5	10.6	...	2.4	4.3	6.7
H25	10	0		9.4	2.3	4.2	15.9
H26	8	10	14.3	...	1.9	3.8	5.7
H27	8	0	9.7	...	2.5	3.2	5.7
H28	5	10	13.8	...	2.0	2.7	4.7
H29	5	5	16.8	...	2.0	3.8	5.8
H30	8	0		9.8	2.3	4.3	16.4
H31	7	0		8.8	1.6	3.0	13.5
H33	8	5	12.5	...	2.4	4.6	7.0
H34	12	5	14.4	...	1.9	4.2	6.1
H35	5	5	11.6	...	1.8	4.0	5.8
H36	5	10	15.9	...	1.9	3.9	5.8
Average			11.5				7.2

## CHEMICAL SEGREGATION OF INGOTS OF BOTH TYPES

Each Maryland ingot furnished six and each Hadfield ingot four rails, as shown in Fig. 2.\* In studying segregation in the "A" test piece it should be remembered that for the sink-head ingots this position is that of the drop test piece at about 9 per cent below the top (including sink-head), while for the comparison ingots the "A" test piece is at the junction of the "X" and "A" rails, or at 10.6 per cent from the top of ingot. They are placed in sufficiently similar position therefore for the comparison, except that 10.6 per cent of a comparison ingot (7,260 lb.) includes 770 lb. or 23 ft. of rail, while 9.6 per cent of a sink-head ingot (5,300 lb.) contains 509 lb. or only 15 ft. of rail. The "A" position in the comparison thus has an average rail discard 8 ft. greater than the sink-head ingot.

The "E" position of the rails from sink-head ingots should be compared with the "F" position of the comparison ingots, the sink-head "D" with comparison "E," the sink-head "C" with comparison "C" and "D," and the sink-head "B" with comparison "B."

\*See p. 924.

**Chemical Tests.** Determinations were made of the amounts of carbon, sulphur, phosphorus, manganese and silicon at the "O" and "M" positions (Fig. 4) for test pieces (B, C, D, etc., of Fig. 2) of all the rails. "X" and "A" rails of the comparison ingots and "A" rails of the Hadfield ingots were broken in 5-ft. pieces and analyzed with results, the more typical of which are included in Table XIII. Some specifications contain a clause which provides for the rejection of rails when the "M" position shows a carbon content more than 12 per cent greater (positive segregation) or more than 12 per cent less (negative segregation) than the "O" position. In the present investigation all material showing more than 12 per cent positive or negative carbon segregation was considered as unavailable for rails. The railroad using this specification has found from experience that 12 per cent is the maximum safe limit of segregation.

For both types of ingot, as shown in Table VIII, the longitudinal segregation of carbon is very slight along

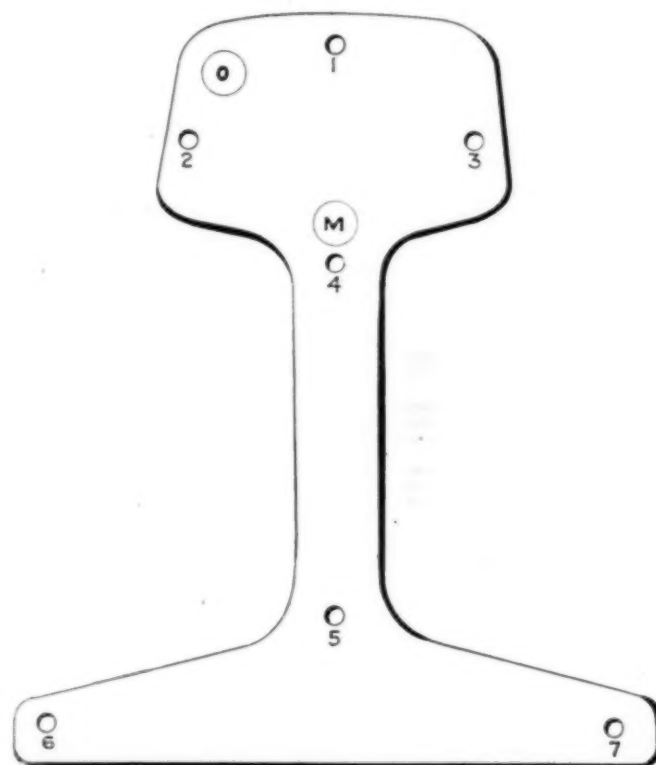


FIG. 4. 100-LB. PENNSYLVANIA RAIL SECTION SHOWING LOCATION OF VARIOUS TESTS

"O" is outer position for chemical analysis.

"M" is middle position of sample for chemical analysis and tensile test.

1 to 7 represent points where hardness was measured.

the "O" or tread positions, while for the "M" (top of web) positions, or along the center line of the ingot, it is quite marked, the carbon being greatest at "A" near the top of the ingot, decreasing to the "H-D" (or "M-E") position, and rising again as the bottom of the ingot is approached. The Maryland results are tabulated for the three types of ingot, but for this effect the type of ingot appears to play less of a role than for other factors.

The segregation of the sink-head ingots and of the three groups of ingots made with small end uppermost are discussed separately with reference to influence and method of manufacture.



TABLE XII. DISCARDS IN RAILS FROM COMPARISON INGOTS

Ingot	A-rail Crop (Ft.)	Cut for Segregation (Ft.)	Top Discard, per Cent		Middle Discard		Total Discard	
			For Segregation	For Soundness	For Segregation	For Soundness	Bottom Discard for Soundness	Chemical
M1	5	60	31.9	.....	32.0	.....	4.7*	63.9
M2	5	40	24.8	.....	34.5	.....	4.3	59.3
M3	5	40	23.9	.....	34.4	.....	3.1	58.3
M4	5	40	23.7	.....	34.5	.....	3.7	58.2
M5	5	50	28.6	.....	33.7	.....	3.3	62.3
Average			26.6		33.8		3.8	60.4
M6	5	45	25.3	.....	.....	1.5	5.0	25.3
M7	5	30	23.7	.....	.....	1.3	3.9	23.7
M8	5	40	23.3	.....	.....	1.6	4.0	23.3
M9	5	40	23.8	.....	.....	1.1	4.8	23.8
Average			24.0			1.4	4.4	24.0
M11	5			29.0	.....	1.6	5.1	0.0
M12	5	30	19.8	.....	.....	1.7	5.0	19.8
M13	5			39.5	.....	1.0*	4.1	0.0
M14	5	30	.....	28.2	.....	1.6*	4.6	0.0
M15	5	35	.....	27.4	.....	1.9†	4.8	0.0
Average			26.8			1.6	4.7	4.0
Grand average								30.0

\* M13 and M14 contain a trace of piping in B position.

† M15 has a small pipe at F.

## SEGREGATION IN SINK-HEAD INGOTS

The sink-head ingots were of "piping" steel deoxidized with aluminum. Each is from a separate heat of converter steel.

These ingots are, in general, of remarkable uniformity as regards segregation (Table IX), thus showing the furnace and casting practice also to have been very uniform. At the "A" test piece 9.1 per cent below the top of the ingot on the average, the segregation, though variable, is always positive—i.e., the carbon content of the "M" position is greater than that of the "O" position. Fourteen of thirty-five ingots have a segregation greater than 12 per cent and three greater than 25 per cent; for one of these (H13), the "A" position is only 5.1 per cent below the top of the ingot (Table VI).

For these thirty-five sink-head ingots, the discard for segregation above 12 per cent is located 13.0 per cent plus or minus 1.86 below top of ingot, with a maximum of 17.5 per cent and a minimum of 5.1 per cent (Tables VI and XI).

## SEGREGATION IN COMPARISON INGOTS

Group M1 to M5, Heat 2x4497. This heat has no aluminum addition in molds, and cast-iron caps were put on the tops of the ingots as soon as poured. It was found that the ingot tops were rounded after the steel had solidified; therefore they were made of rising steel not specially deoxidized in the mold. The ingots were stripped 20 min. after casting and remained in soaking pits from 2 hr. 10 min. to 2 hr. 23 min. This is about as rapid handling of ingots in the molds as it is possible to have, although the time in pits could have been lessened. The resulting composition and segregation is strikingly characteristic of the history.

The top of the ingot is characterized by high and variable segregation; thus the total top discard required to eliminate segregation above 12 per cent ranged from 23.7 to 31.9 per cent for the five ingots, as compared with a top discard of 2.6 to 9.3 per cent to the physically sound steel—i.e., free from pipe. Tables VI and XII.) Within this range of discard for segregation,

TABLE XIII. CARBON SEGREGATION ALONG TOP RAILS

Ingot		Top	"O" Analysis	"M" Analysis	Segregation per Cent
Hadfield 1	Top		0.632	0.902	42.72
			0.649	0.789	21.57
			0.647	0.732	13.14
			0.650	0.683	5.08
			0.658	0.673	2.28
Hadfield 2	Top		0.610	0.967	58.52
			0.636	0.804	26.42
			0.635	0.705	11.02
			0.632	0.690	9.18
Hadfield 8	Top		0.649	0.758	16.80
			0.656	0.690	5.18
			0.657	0.673	2.44
			0.659	0.661	0.30
			0.654	0.662	1.22
Hadfield 13	Top		0.657	0.664	1.07
			0.627	0.786	25.36
			0.645	0.739	14.57
			0.649	0.664	2.31
			0.657	0.667	1.52
Hadfield 17	Top		0.667	0.699	4.80
			0.675	0.705	4.44
			0.669	0.686	2.54
			0.657	0.688	4.72
Hadfield 21	Top		0.676	0.809	19.67
			0.674	0.707	4.90
			0.680	0.708	4.12
			0.650	0.754	16.00
			0.646	0.682	5.57
Hadfield 29	Top		0.638	0.667	4.55
			0.646	0.717	10.99
			0.643	0.679	5.60
			0.647	0.657	1.55
			0.655	0.646	-1.37
Hadfield 31	Top		0.658	0.668	1.52
			0.650	0.665	2.31
			0.489	0.619	26.84
			0.564	0.630	11.70
			0.554	0.731	31.95
Maryland 1	Top "X" rail		0.573	0.848	47.99
			0.579	0.808	39.55
			0.588	0.791	34.52
			0.816	0.750	21.75
			0.637	0.740	16.17
Maryland 2	Top "A" rail		0.629	0.707	12.40
			0.638	0.683	7.05
			0.631	0.717	13.63
			0.629	0.662	5.25
Maryland 2	Top "X" rail		0.511	0.886	73.39
			0.558	1.086	94.62
			0.602	0.915	51.99
			0.622	0.898	44.37
			0.630	0.894	41.90
Maryland 5	Top "A" rail		0.644	0.879	36.34
			0.619	0.849	37.16
			0.641	0.811	26.52
			0.589	0.672	14.09
			0.605	0.777	28.43
Maryland 5	Top "X" rail		0.621	0.927	49.28
			0.626	0.919	46.81
			0.652	0.844	29.45
			0.630	0.786	24.76
			0.647	0.761	17.62
Maryland 5	Top "A" rail		0.652	0.700	7.36
			0.658	0.734	11.55
			0.641	0.721	12.48
			0.618	0.685	10.84
			0.648	0.701	8.18
Maryland 6	Top "X" rail		0.662	0.754	13.90
			0.666	0.703	17.57
			0.677	0.807	19.20
			0.674	0.769	14.09
			0.684	0.766	11.99
Maryland 6	Top "A" rail		0.683	0.769	12.59
			0.690	0.727	5.36
			0.626	0.545	-12.94
			0.654	0.685	4.74
			0.671	0.746	11.18
Maryland 9	Top "X" rail		0.656	0.839	27.90
			0.700	0.841	20.14
			0.688	0.818	18.90
			0.699	0.800	14.45
			0.705	0.786	11.49
Maryland 9	Top "A" rail		0.706	0.764	8.22
			0.706	0.743	5.24
			0.703	0.735	4.55
			0.620	0.816	31.61
			0.671	0.830	23.70
Maryland 12	Top "X" rail		0.670	0.871	30.00
			0.701	0.887	26.53
			0.710	0.806	13.52
			0.699	0.778	11.30
			0.698	0.745	6.73
Maryland 12	Top "A" rail		0.692	0.713	3.03
			0.696	0.672	-3.45
			0.680	0.686	0.88
			0.714	0.684	-4.20
			0.711	0.742	4.36
Maryland 14	Top "X" rail		0.694	0.756	8.93
			0.700	0.781	11.57
			0.692	0.783	13.15
			0.705	0.776	10.07
			0.705	0.746	5.82
Maryland 14	Top "A" rail		0.706	0.736	4.25
			0.708	0.705	-0.42
			0.682	0.679	-0.44
			0.701	0.637	-9.13



FIG. 5. RAIL M4-F

Sulphur print shows soft streak in web from bottom of ingot.  
A—Moderately fine grained structure, pearlite with a thick irregular ferrite network, and ferrite clusters. Soft streak in web of rail.

B—Average moderately fine grained structure, pearlite with a trace of ferrite.

however, the segregation in a single ingot varied by enormous amounts, such as 26.52 to 94.62 per cent for ingot M2 and —7.36 to 49.28 per cent for ingot M5 (Table XIII). This type of ingot is also characterized in all cases by high negative segregation in the lower portion of the ingot, particularly marked at the "E" position, where it ranges from —12.34 per cent to —15.89 per cent (Table X). Except for M1, at the bottom of the ingot "F" position (—13.45 per cent, Table X), there is a reversal to relatively small positive segregation. All but M2 contain a well-marked soft streak at F, the bottom of the ingot, and in the case of M5 this streak encloses a very bad pipe (Figs. 5 and 6). The total material that should be discarded from this type of ingot for segregation ranges from 58.2 to 63.9 per cent (Table XII). Provision should be made for a larger bottom bloom crop than is customary, to eliminate both segregation and piping in the bottom of the ingot. The bottom rail and the one next the bottom of every ingot of this group (M1 to M5) should be discarded for segregation, and the bottom rail has in addition elements of physical weakness shown by the soft steel streaks which may enclose pipes.

*Group M6 to M10, Heat 1x3632.* The ingots of this heat had rounded tops on which water was put a few moments after casting; they were also treated, while being cast, with 2 oz. of aluminum per ton of steel. They were, therefore, of rising steel deoxidized in the

molds, and should show somewhat greater tendency to piping than the first group; this is borne out by the results. The ingots of the second group required a discard averaging 8.0 per cent on account of pipe, while only one of the first group required a discard in excess of this amount (Table VI).

With respect to the "B," "C," "D," "E" and "F" positions for this group, the segregation is relatively low (max. 9.20 per cent, Table X) and uniform from one ingot to another as well within any particular ingot downward from the "B" position. The top discard for carbon segregation greater than 12 per cent (in "O" and "M" positions) is 23.3 to 25.3 per cent (Table XII) and within this discard the segregation is less extreme than in ingots of the first group, the maximum being about 25 per cent, which is attained in only two positions out of twenty-nine (Table XIII).

*Group M11 to M15, Heat 2x4510.* Two ounces of aluminum per ton was added to the ingots M11 to M15 for the purpose of deoxidation. The ingot tops, which were flat after pouring into molds, were not chilled with caps or water. These ingots were, therefore, of quiet, piping steel and apparently more nearly approach the type of steel represented by the Hadfield ingots than do the other two groups of Maryland ingots. They remained somewhat longer in the molds, 30 min. as compared with 20 and 23 min., before stripping and slightly longer in the soaking pits than the other comparison ingots.

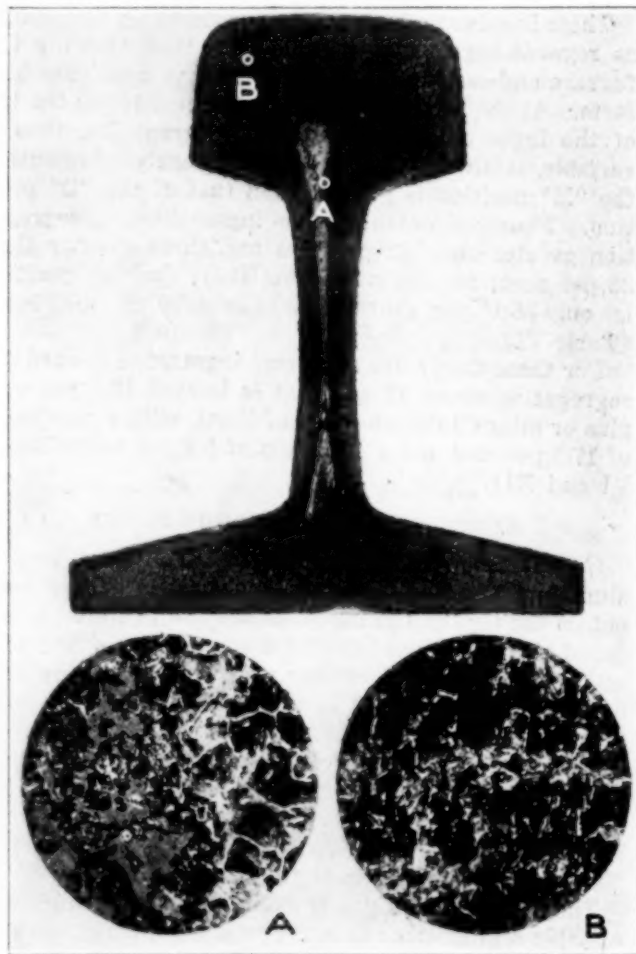


FIG. 6. RAIL M5-F

Sulphur print shows pipe in rail from bottom portion of ingot.  
A—Structure along edge of bad pipe, eutectoid streak with large amount of slag bordered by hypo-eutectoid streak.  
B—Average moderately fine grained structure, pearlite with a trace of ferrite network and slag.



The considerable piping at the top of the ingots of this group is very strikingly characteristic of the above open-hearth and casting practice. The carbon segregation in the upper half and at the bottom of this type of ingot is slight, but there is developed negative segregation, ranging about 11 per cent at the "D" and "E" positions (Table X). In contrast to the other two types of Maryland ingot, except for M12, which shows other anomalies, the extent of the top discard is determined by piping (average discard 26.8 per cent) rather than by segregation (average discard 16.4 per cent; Table XII). The metallographic examination shows a small pipe in rail M15 at the bottom of the ingot in the "F" position, and incipient piping in M13 and M14 at the "B" position.

A striking characteristic of this group (M11 to M15) is the freedom from segregation in the "A" position; excluding M12A for which the segregation at "A" is 32.52 per cent, the average for the others is about 2 per cent segregation at the "A" position (Table X). M12 also possesses the following irregular segregation characteristics; at "A" there is segregation to such an extent that the microstructure is that of a hyper-eutectoid steel; at "B," a narrow hypo-eutectoid streak; at "C" there is the same structure as at "A"; and again at "D" a heavy hypo-eutectoid streak.

*Segregation of Elements Other Than Carbon.* In general it might be expected that the elements sulphur and phosphorus would follow carbon in segregation characteristics, and that manganese, silicon, chromium and nickel would show little or no segregation. These expectations are borne out in both the sink-head and comparison ingots.

Detailed studies showed longitudinal segregation of phosphorus to be absent for the "O" (tread) position and slight for the "M" (web) position. There is practically no longitudinal or transverse sulphur segregation in the sink-head ingots, while for the comparison ingots, the results on sulphur segregation are erratic (Table VIII), but on the whole follow the carbon segregation.

For the elements manganese, nickel, chromium and silicon there is no well-defined segregation within the ingot.

*Part III will be published in a subsequent issue.*

### Analysis of Samples of Ancient Armor

The analysis and microscopical examination of about one dozen samples of ancient armor from the Metropolitan Museum of Arts, New York, have been practically completed by the Bureau of Standards. The analysis indicates that all the samples were made from very pure wrought iron converted into steel by the old cementation process, as would be expected.

The carbon determination was made on the entire cross-section, as the material of all the pieces was too thin and corroded to obtain samples from different layers.

The microstructure indicates that the process used in the production of the original iron was very similar to our wrought-iron process. The metal was then carbonized, probably by a supplementary process, hammered into sheets, differing in hardness—i.e., in the amount of carburization—and these sheets were welded together.

The whole was then hammered into shape and quenched, thus producing the final hardening effect.

### New Hydro-Electric Project in Scotland

A project is on foot—and is, in fact, already taking concrete form—for the utilization of the water power now running to waste in the watershed of the Tay, with a view to generating an increased supply of electric energy for the counties of Forfar, Perth and Fife in Scotland, reports Consul H. A. Johnson of Dundee. Two schemes having the same object in view have already been before the public. In the first instance the government, through its water-power resources committee, investigated the possibilities of the Highland lochs and received reports upon nine distinct undertakings, the most productive of which, from the standpoint of power, was that in central Scotland for the utilization of the energy of Lochs Erich, Laidon, Rannoch and Tummel. These, it was stated, would be capable of developing a continuous supply of 42,000 electrical horsepower at a cost on a pre-war basis plus 50 per cent of £1,580,000 (\$7,689,000).

The second was a project of the Dundee Corporation, which called for an expenditure of £4,000,000 to £5,000,000 (roughly \$20,000,000 to \$25,000,000), and under which it was proposed to utilize Lochs Erich, Rannoch and Tummel. It was generally believed, however, that the task was too formidable for a city of the size of Dundee to undertake.

#### FEATURES OF THE NEW PLAN

The scheme now proposed is said to differ materially from those heretofore discussed. It appears that the matter now is in the hands of a group of business men and financiers, who have been investigating the possibilities of Lochs Erich and Garry. It is claimed that from these two lochs alone 100,000 hp. can be developed with little difficulty, and this would be sufficient to furnish power and light to the three counties before mentioned. Italian engineers have been making extensive surveys through the Atholl Forest along Lochs Garry, Rannoch and Erich. One of the noteworthy features of this new scheme is that there will be little damage to either sporting or agricultural interests, while under the Dundee Corporation scheme local opposition arose because of the destruction that plan involved. At this stage figures as to probable cost are not available.

#### ULTIMATE RESULTS EXPECTED

As to the ultimate results it is believed that there will be light, heat and power available for the three counties (which embrace the cities of Dundee, Perth, Forfar, Arbroath and Montrose) not only for the requirements of today but allowing for future expansion. It is understood that the company will not sell the power to the consumer but will bring it down to the various local authorities, who will buy it and distribute it themselves.

### Manufacture of Fertilizers in South Africa

An explosives works near Cape Town is now erecting a large plant for the manufacture of fertilizers, which are very essential where agricultural industries are carried on in South Africa. Superphosphates, basic phosphates and nitrogenous fertilizers will be made. Small quantities will be available for the coming season. When the plant is running at full capacity—which will not be until next year—it will be capable of meeting the entire demand of South Africa.

## Report of the Activities of the German Board of Trade During the War\*

A Summary of the Official Board of Trade Report on the Conditions in Chemical and Allied War Industries, With Tabulated Data on the Wage Conditions and Accidents for the Period 1913-1918

THE extraordinary circumstances created by the war in the trades and industries have necessarily influenced the activities of the German Board of Trade. The reports of the Prussian Administration and Trade Authorities for the years 1914-1918 (official edition published by the Secretary of Commerce and Trade, Berlin, 1919) consist of a portly volume of 1,700 pages, giving an almost exhaustive account of the field of activity of the various officials of the Board of Trade and at the same time containing important documents on the German war industry.

The numerous articles in the German and foreign literature about the industrial production during the war have somewhat exhausted the subject; the official reports, however, treat matters from an entirely different standpoint. Much has been written about the important extension of the industries essential to war and of how astonishingly quickly the non-essential works had adapted themselves to the necessities of the day; but the influence of these changes and transformations on the general conditions of the working people is generally treated as a matter of secondary consideration. The official reports dwell at length on this influence. Page by page we are shown what efforts of all the interested parties were necessary, especially in view of the reduced personnel and the insufficiently trained substitutes to keep pace with the steadily increasing demands of the army and the war economy.

The fact that under such exceptional circumstances, aggravated by the steadily and increasingly depressing effects of the blockade, the accident-preventing measures and those for the hygienic protection of the workers did not suffer any noticeable impairment must be considered as a great feat for the German industry.

### SPECIAL ACTIVITIES OF THE TRADE-CONTROL OFFICIALS DURING THE WAR

The normal activity of the Trade-Control officials during the period referred to was greatly burdened by the drafting of many of them into army service, and above all by the enlarged scope of their task, such as the examinations of the applications for leave of absence from the army and reinstatement in industrial work, the probing of applications for the release of confiscated materials and other such occupations benefiting the war departments to the detriment of the war industries. In addition these officials were called upon to give opinions and suggestions for the classification of the workers in very essential, essential and less essential occupations, to the co-operation in the care of war invalids, to help in the distribution of food, clothing and shoes, to handle the prisoners of war and even to handle the distribution of medals and certificates of

distinction—activities which, as can be easily surmised, are largely foreign to the Trade-Control Service when functioning under normal conditions.

### INTERFERENCE OF THE MILITARY AUTHORITIES IN THE WORK OF TRADE INSPECTORS

The suddenness of the technical adaptation of many works for the production of ammunition brought the trade inspectors up against an accomplished fact before even they could take measures for the better security of the workers and of the population.

Complaints came in from the Government Trades Department of Potsdam that the military authorities had deliberately omitted to consult the trade inspectors about the advisability of changing certain works and that they encouraged many firms in their resistance against the trade officials. Similarly, reports came from the Department of Erfurt that most of the employers, encouraged by a circular from the Quartermaster General, considered that all the usual works safety measures were abolished. One may understand this procedure of the military authorities when the pressing demands from the "front" are recalled.

### ACCIDENTS IN THE EXPLOSIVES INDUSTRY

In the course of the war, improvements were gradually introduced in practically all the industrial branches, particularly in the explosives industry. Factory experiences were exchanged. This was largely brought about by the important services rendered by a central war control office and a committee for the superintendence of munition and explosives factories.

The reports published by the unions in the chemical industries of all the accidents which occurred in the empire were of great help in improving working conditions. If, for instance, in seventy works in the Department of Potsdam, where explosives were manufactured, manipulated and stored, seventy death cases occurred through fires and explosions, such a death rate could not be considered as high, particularly in view of the circumstance that among the thousands of drafted workers many were physically and professionally poorly qualified for this line of work.

The Köln-Rottweiler powder factories in Premnitz for the manufacture of nitro compounds, erected in the course of the war, are given as an example for the average accident occurrences in this industry. Thus, with an average working force of 3,000 employees, the following accidents occurred during the years 1917 and 1918:

	Kind of Accident		
	Slight	Serious	Fatal
Burns by spilling of acid .....	33	17	..
Burns through fires in the centrifuges .....	18	8	..
Burns through ignition of gun-cotton and powder .....	6	4	12
Burns through ignition of cannon charges .....	..	..	2
	57	29	14

\*Abstracted and translated from *Chemiker-Zeitung*, July 11 and 17, 1920.



TABLE I. YEARLY WAGES IN MARKS IN INDUSTRIAL TRADES IN THE POTSDAM DISTRICT (TRADES GROUP VII)

		Workers Under 16 Yrs. Old			Female Workers Over 16 Yrs.			Male Workers Over 16 Yrs.											
		Time Work			Piece Work			Unskilled						Skilled					
		1913	1915	1917	1913	1915	1917	1913	1915	1917	1913	1915	1917	1913	1915	1917	1913	1915	1917
Greater Berlin District	State Institutions in Spandau	a500	900	1,100	700	1,200	1,800	900	1,600	2,300	1,200	1,500	2,200	1,700	2,400	3,700	2,000	3,100	3,700
		b600	1,100	1,200	900	1,500	1,900	1,000	2,300	3,000	1,500	2,200	3,000	3,300	3,300	3,900	2,100	3,400	4,500
Other Greater Berlin Works		a400	700	1,200	600	1,000	1,500	900	1,600	1,700	1,000	1,800	3,500	1,600	2,400	4,000	1,900	3,200	3,800
		b600	800	1,500	800	1,500	1,800	1,200	2,100	3,200	1,500	2,400	3,700	1,900	2,900	4,200	2,300	3,700	4,400
Rural District		a400	500	800	500	700	1,000				800	900	1,200	1,500	2,300	2,300	1,300	1,600	2,400
		b500	1,000	1,200	900	1,100	1,500				1,600	2,000	2,800	2,500	3,600	3,600	1,600	2,400	4,700

a Average minimum wage.

b Average maximum wage.

The reports of the Trade-Control Service bring out the details of these and similar accidents in many other works.

#### DEVELOPMENT OF THE WAR-TIME WAGE CONDITIONS

Special tabulated references are devoted to the development of the war-time wage conditions.

The increases in wages during the years of war appear relatively small when compared with the present scale of wages, which shows such an abrupt rise since the outbreak of the November, 1918, revolution. However, there was generally an increase of 100 to 150 per cent above the peace-time wages.

TABLE II. AVERAGE WAGES PER HOUR IN PFENNIGS IN BITTERFELD DISTRICT (TRADES GROUP VII)\*

Trade	July 1916			Dec. 1918			Remarks
	1914	1915	1916	1917	1918	1918	
Locksmith	47	48	57	68	85	155	Add to this a bonus
Building	45	45	55	64	77	130	for children in some
Engineer helpers	42	42	49	56	69	127	factories. During
Factory workers	42	42	47	54	67	124	1915 and 1916 the
Laboratory workers	38	38	45	56	69	118	weekly bonus was
All round workers	34	34	41	48	67	113	0.35 to 1.20 marks.
Youths				42	52	65	During 1917 and
Female workers				37	45	80	1918 the hourly

\* Note the great increase in wages from July, 1918, to shortly after the signing of the armistice.

The developments in the wage conditions of today have their inception in the years of war—a fact which cannot be emphasized enough.

Tables I, II and III show examples of the average yearly, hourly and daily wages for workmen before and during the war.

#### SOCIAL WAR WORK IN THE INDUSTRIAL DISTRICTS

Great efforts were made by the War Industries Department to supply the workers with food and clothing in order to better their living conditions. For example, 10,000 persons were fed daily in two shifts by the Rheinische Metallwaren und Maschienenfabrik. The Farbenfabriken vorm. Friedr. Bayer & Co. in Leverkusen spent during the war for such purposes the round sum of 4,500,000 marks for distributing daily 8,000 dinners and about 9,000 war soups. A big cloth factory in the district of Dusseldorf supplied its employees

with large quantities of potatoes, cereals, milk, meats, etc., by leasing a 90-acre farm and also by cultivating the land around the factory. The Bergische Stahlindustrie in Remscheid established shoe-repair works and clothing depots for their workmen and their families.

Many other similar examples are described.

The reports also contain a series of interesting details about the development of the social aspects in industrial works during the war.

#### WOMEN AS INDUSTRIAL WORKERS

As a result of the increasing demands for men, a great proportion of the workmen was drafted for military service and practically all factories were forced to take in women as substitutes. This generally had good results. As a general rule the women were not required to do too hard physical work. Naturally they were primarily considered for work at which unskilled labor had been previously employed. In the course of the war, however, many of them acquired knowledge of trades and became skilled workers. Occasionally women (in automobile factories) succeeded in getting the necessary training for machining shafts and spindles from working drawings.

Many employers, to reduce the physical effort of their women employees, introduced mechanical devices for lifting and other similar devices which proved to give greatly satisfactory results, especially in the ammunition industry.

#### SPECIAL LINES OF WORK PERFORMED BY WOMEN INDUSTRIAL WORKERS

Among the many special lines of work performed by women may be mentioned the following: Adjusting small motors, blacksmithing and mechanical work, making dies for punching machines, making, assembling and adjusting turbines; in the wood industry, veneering; in the chemical industry, filling grenades, gas mines and bombs, manufacturing powder, rockets; in the sugar factories, beet weighing and at the apparatus for diffusion, saturation, evaporation and vacuum. In the iron industry women were sometimes employed for handling the steam hammers. In the powder fac-

TABLE III. AVERAGE DAILY WAGES IN MARKS IN THE COLOGNE DISTRICT

Month of July	Youths			Unskilled Workers			Trained Workers			Skilled Workers		
	1914	1917	1918	1914	1917	1918	1914	1917	1918	1914	1917	1918
EXPLOSIVE WORKS (AMMUNITION PLANTS)												
Men	1.75	9.00	11.00	.....	15.50	17.00	4.68	17.00	19.00	5.00	10.50	12.00
Women	.....	8.50	10.40	.....	12.10	13.00	.....	14.00	15.00	.....	.....	.....
OTHER CHEMICAL WORKS (ACID AND ALKALI PLANTS)												
Men	2.50	4.50	6.50	4.00	8.00	9.50	4.80	11.00	13.00	5.50	13.00	16.00
Women	.....	3.00	4.00	.....	5.00	6.50	.....	.....	.....	.....	.....	.....

tories they worked in the drying and mixing rooms, at powdering, screening, cutting and grinding machines; some women were employed to handle even the presses and in some instances they were called upon to handle the very dangerous kneading work.

The Control officials often made special mention of the courage women showed in performing very dangerous work.

The law of Aug. 4, 1914, gave the legal permission necessary for women to be allowed to do overtime and night work. During the war all the factories worked on the two and three shifts plan, with the result that night work steadily increased.

Complaints came from time to time about the moral deportment of the women workers; the increase in earnings resulted in the very detrimental policy of spending excessively for luxuries and amusements. In spite of this, the help of the women workers will be remembered with a feeling of deep gratitude. The male substitutes brought into the factories by the law regulating the auxiliary service did not prove as efficient by far as the women substitutes.

#### WAR-TIME ABROGATION OF THE CHILD LABOR LAW

The occupation of youthful persons also was extended largely. Very often the strict execution of the legal child labor protection measures had to be overlooked. The conduct of the youths in the factories was the subject of many complaints. The apprentice institution was badly neglected. Numerous young people did not enter in a factory as apprentices, but entered directly in the war industries as helpers. Due to the prevailing need for workers, apprentices were kept doing regularly one and the same kind of helper's work and consequently they could not learn anything else of the trade.

The lack of raw materials in many branches caused the discarding of many trades altogether. In many cases the employers had to be reminded not to lose sight of the interests of the trade when normal times should arrive and afford to their apprentices a regular trade instruction.

#### STATISTICS OF INDUSTRIAL ACCIDENTS FOR THE PERIOD 1912-1918

As stated before, the hygienic condition of the various factories was very satisfactory when the exceptional conditions created by the war are considered. It is surprising to find that in those groups of industries which employed the largest number of workers and where the absolute number of accidents had naturally increased there was a lower relative percentage in the frequency of accidents. (See Table IV.)

This is explained by the fact that even in the branches of ammunition production, to which the trade-groups listed as V, VI and VII owe their powerful development, the number of persons employed in non-dangerous and easier kinds of work was the larger. Another cause was the introduction of the method of working by shifts, which did not permit the workers to get overtired.

The relative number of accidents in factories with

TABLE IV. INFLUENCE OF THE WAR ON THE NUMBER OF ACCIDENTS

	Average Accidents Reported in 1912 and 1913 per 1,000 Workers			Average Accidents Reported in 1914 and 1915 per 1,000 Workers *			Percentage			Total
	Slight	Serious	Fatal	Slight	Serious	Fatal	1913	1914	1915	
Quarrying and excavating.....	320	24	7	351	18	3	1.866	198	18	219
Group IV. Metallurgical industry, machines and apparatus.....	7,118	89	19	7,226	123	18	7.13	7,920	123	8,061
Groups V and VI. Chemical industry.....	727	16	5	748	9	4	12.06	522	9	535
Group VII. Textile industry.....	316	9	2	327	10	2	2.95	233	10	245
Group IX. Food industry.....	985	22	4	1,011	32	4	4.29	1,030	32	1,066
Group XIII. All the industries and trades.....	11,791	248	50	12,089	240	42	5.62	11,798	240	12,080

\* The percentage could not be figured out, as there are no reliable data on the number of employees during 1914

reduced personnel was much greater, due to the fact that the best and most reliable employees were lost either by drafting to the war service or by migration into ammunition industries, in consequence of which difficult work was often performed by unskilled substitutes.

#### ACCIDENTS DUE TO THE TOXICITY OF THE MATERIALS USED

The fatal cases from poisoning by nitrous gases were relatively numerous, due to the increased number of plants for the production of explosives. The poisoning effect of the finished explosive materials in plants taking up the filling was generally not so apparent. Only dinitrophenol makes an exception, causing occasionally serious poisonings with quick fatal issue.

Nitroglycerol should be treated more cautiously than nitroglycerine on account of its higher volatility. In manipulating it the workmen experienced at first a feeling of dizziness and blood congestion; later they became used to it.

Trinitroanisol produced dermatitis and eczema by the action of its dust particles on the unprotected skin. In a plant where the hygienically harmless trinitrotoluol was employed several persons died one after the other, all from acute atrophy of the liver. This was probably due to the use of a trinitrotoluol which was admixed with poisonous impurities.

Unpleasant skin eruptions occurred, particularly in summer time, at the plants using silver fulminate, but no serious poisonings ensued from this cause.

The toxicity of benzene is as a rule underestimated; it was employed on a large scale as a substitute for benzine and was not treated cautiously enough. Quite a number of death cases occurred in benzene depots and in laundries from this cause. Painters and varnishers suffered much through the vapors of benzene, which was an ingredient of their paints, particularly when confined to the narrow space of a ship. Similar hardships resulted at the manufacturing and manipulation of cellon varnish, which was extensively used for various purposes; the solvents for it (ketones, methanol, chloroform, ethyl formate) caused dizziness and fainting spells, also irritation of the eyes.

#### ACCIDENTS DUE TO THE USE OF SUBSTITUTE MATERIALS

The use of Ersatzmaterialien—substitute materials—led to unexpected accidents. The serious explosion which destroyed the trinitrotoluol factory of the chemical works Griesheim-Elektron, in November, 1917, was due to the overheating and burning of a nitrator. This accident, it is explained, was caused by the fact that the asbestos rope used for tightening the manhole cover contained a large admixture of cotton which had undergone a nitrification and ignited spontaneously.

## IN SOME IMPORTANT TRADES GROUPS IN THE POTSDAM DISTRICT

Average Accidents Reported in 1916 and 1917 per 1,000 Workers						Accidents reported in 1918 per 1,000 Workers						Number of Employees		
Slight	Serious	Fatal	Total for 1917	Percentage		Slight	Serious	Fatal	Total	Percentage		1913	1917	1918
145	14	2	161	2.59		183	14	1	198	2.96		18,830	6,216	6,678
11,163	266	43	11,472	5.51		10,797	259	36	11,092	5.35		101,282	208,188	207,181
693	29	5	727	4.70		815	48	13	876	4.08		6,200	15,453	21,457
210	15	2	227	3.79		186	6	..	192	3.63		11,106	5,977	5,284
679	37	3	719	4.65		499	22	6	527	3.40		23,533	15,465	15,500
14,570	452	63	15,085	5.29		14,004	436	68	14,058	4.95		215,195	285,199	292,947

and 1915.

In a compressed air plant a rather serious explosion occurred when instead of the war lubricating oil, which gave up considerable pitch, a cylinder oil of a 200 deg. C. flash point admixed with petroleum was used for the compressor; the petroleum probably formed an air mixture, igniting at 140 deg. C., the temperature of the exit air in the compressor.

The bad material for belting caused many accidents.

Skin eruptions produced by oils assumed proportions unknown heretofore. They occurred on persons who had to work with substitute lubricating and drilling oils. The use of unfit substitutes and the lack of cleansing and washing articles were the main causes for it. Women particularly had to suffer from these annoying skin diseases, which appeared usually on the hands and forearms, but spread also to other parts of the body and very often caused fever and general impairment of health. In many works petrolatum was distributed as a protective ointment; linoxyl soap was recommended as a cleanser.

## OTHER ACCIDENT CAUSES

A woman working at the turning bench of a cartridge factory had her celluloid comb take fire by a glowing steel chip and suffered in consequence serious burns.

At a plant manufacturing aceto-acetic ester two workmen died from burns. The cause is explained by the fact that during the chemical reaction combustible vapors were given off and were ignited by the sparks of a passing locomotive.

In filling bottles with fluid hydrocyanic acid from steel containers an explosion occurred, killing two men; later on several more containers exploded—this time in the yard.

The report adds: "After thorough investigation, fluid hydrocyanic acid is to be classed as an explosive material and its use for the destruction of moths in mills appears doubtful." This remark goes too far and is misleading. Fluid hydrocyanic acid is under certain conditions sufficiently stable, but requires careful handling.

In some instances hydrogen was pumped, by mistake, into oxygen containers and this resulted in many accidents. The cause of the mistake was that the oxygen and hydrogen containers could not be clearly distinguished. This was remedied by making the containers and the caps of different diameters for the two kinds of gases.

Very little white lead was manufactured during the war, and on account of this few cases of lead poisoning were reported. There was an increase in lead poisoning cases in the printing trades due to the lack of washing materials. The Farbenwerke A.-G. in Dusseldorf took advantage of the standstill of their white-

lead plant to introduce improvements not requiring manual labor in their oxidation chambers.

## LIQUID AIR AS A BLASTING MATERIAL

Of special interest are the reports of the superintendents of the mining districts covering statements about the introduction of the air-blasting process and the accidents caused by it. As there was

a big shortage of safe blasting materials from the beginning of the war, the use of liquid air as a blasting material started as early as 1915. According to the opinion of the inspecting officials, few of the accidents which occurred were due to the use of the new blasting method. The poor quality of the accessories—ignition cord, blasting capsules, spark plug—was the direct cause of many accidents in blasting with liquid air.

## Use of Compressed Gas in Foreign Countries

A number of consular officers have made special reports on the use of compressed gas. These reports may be examined at the Bureau of Foreign and Domestic Commerce or its district offices.

Consul General Roberston, at Buenos Aires, Argentina, reports that it is used for various purposes. The gas is manufactured locally and the output of the factories is used by the entire republic. The machinery for its manufacture was originally imported from France and Germany. The consul general says that there should be a fair market for equipment for utilizing gases for industrial, hospital and laboratory uses. The most feasible method of marketing machines for gas manufacture or for its application industrially is by giving the representation to one of the large American commission houses which has the advantage of technical experts and knows the machinery market thoroughly.

Compressed gases are used in Ottawa, Canada, according to Consul General John G. Foster, in connection with industrial establishments and hospitals. The hospitals and the dentists obtain their supply from the dental-supply houses, the largest being in Montreal and Toronto. It is stated that these firms, which have branches in the principal Canadian cities, import all the gas and oxygen used from the United States. Importation is made in large cylinders, the gas being repumped into smaller ones for distribution.

Vice-Consul John C. Moomaw, at Bombay, India, writes that compressed gases are generally used by the principal engineering, shipping, dock and railway concerns in his district for welding and cutting metal; also in many of the hospitals. The gases are of local make, being supplied by a branch of a large British house, which also furnishes machinery and equipment for gas application.

In Sweden compressed gases are being used extensively for welding, according to a report by Consul Walter Sholes, at Goteborg. Shipyards and larger shops produce the gas in their own plants instead of buying cylinders with compressed gas. Machinery for the production of compressed gas was formerly obtained in Germany and France, but Sweden now supplies its own markets.



## The Present Status of the Electric Furnace in the American Metal Industries\*

Present Technology and Future Possibilities of the Electric Furnace as Applied in the Manufacture of Synthetic Cast Iron, Steel, Steel Castings, Ferro-Alloys, and in Heat Treating, Brass Melting and the Smelting of Non-Ferrous Ores

BY ROBERT M. KEENEY

THE development of the electric furnace to a position of great industrial importance during the last decade was one of the most noteworthy steps in the progress of metallurgy. In 1910 there were electrometallurgical power loads in about twenty-five cities in the United States and Canada. Today such a load is found in over 200 cities. Ten years ago so little was known of the characteristics of an electric-furnace load that few companies cared to have an electric furnace on their lines. Today, with an electric steel furnace in practically every manufacturing city in the country, the load is considered desirable and is much sought. The wide extension to so many communities is, of course, due mainly to the war. Although the number of steel furnaces installed during the past few years is far greater than could have been foreseen ten years ago, and although many were installed mainly for war purposes, it does not appear that there has been an over-development in this respect. The quality of electric steel has become so well established that the electric process is here to stay, and it will probably eventually supersede other processes for the production of castings, and super-refining will be practiced on a large scale for treatment of molten bessemer and molten open-hearth steel. The electric furnace load of the United States and Canada for the production of steel, ferro-alloys, brass, zinc and silver amounts to approximately 800,000 kva.

### PIG IRON

Although the electric smelting of iron ore was developed simultaneously in the United States and Sweden, and although in 1908 D. A. Lyon erected here in California, at Heroult, the first electric furnace to produce pig iron commercially, the process is no longer in operation in this country. Pig iron is being produced in the United States by electric melting of scrap, not by smelting iron ore. On the other hand, development in Sweden and some other countries has been steady. The furnace used is similar to the shaft furnace installed by Lyon in 1908, which is especially adapted for production of low-carbon and low-silicon iron, but not foundry iron. It operates best with charcoal as a reducing agent, and has proved a failure when operated with coke. The pit type furnace, with no shaft except charging spouts, operates satisfactorily with coke, and also produces foundry iron. The last two furnaces operated at Heroult were of the low pit type, and could be operated with coke and charcoal mixed for production of high-grade foundry iron. In 1910 there were in operation two electric iron-smelting furnaces

of a total input of 3,500 kw. At the present time there are installed thirty-three electric iron-smelting furnaces of from 2,000 to 7,000 kva. capacity, with a total load of 100,000 kva. and a production capacity of 250,000 tons of pig iron per year. During the war production costs have favored electric smelting, so that electric pig iron is now being produced in Sweden for \$5 per ton less than blast-furnace charcoal iron. This is in spite of an increase in power cost of 50 per cent which has raised the average cost of power from \$8 to \$12 per horsepower-year.

Electric-furnace production of pig iron will probably never develop to any great extent in the United States along the line of development in Sweden, because of the high cost of power, but I believe that the time is coming, particularly in the Western States, when pig iron, more specifically cast iron, will be made by melting of scrap iron, scrap steel, iron ore, coke and lime in the electric furnace to produce iron for direct castings or for pigs. During the war a considerable quantity of low-phosphorus pig iron was made in the United States and Canada by electric melting of steel scrap. The Canadian production in 1918 amounted to 32,200 tons. Toward the end of the year it was at the rate of 4,000 tons per month. Six plants were in operation in Canada and two in the United States. There seems to be a future for the process, especially in foundries where the cost of foundry pig iron is high, due to freight. I know of one mountain city where the foundries pay \$55 per ton for pig iron laid down at their plants. Iron in the ladle could there be made by the electric process for \$35 per ton.

The metallurgy of synthetic electric-furnace cast iron, as it is called, was worked out on a large scale in France during the war. Three plants were erected with a total power input of 40,000 kva. During 1916, 1917 and 1918 220,000 tons were made with metal cast direct from these electric furnaces, of which there were sixteen of from 1,000 to 2,200 kva. capacity. Power consumption is from 675 to 800 kw.-hr. per ton of cast iron. Any grade of iron desired can be produced. The process is conducted as a continuous operation, with the furnace kept full of charge. With a large unit the load is very steady, but it is probable that in the operation of small units there might be a tendency to momentary overloads. These would be no worse than in a steel-melting furnace. The power factor of the furnaces is about 80 per cent on sixty-cycle current. A phase voltage of 50 to 70 volts is used.

### REFINING GRAY IRON

Another use of the electric furnace is in refining gray iron from the cupola. Cupola iron, after treatment in the basic electric furnace, shows a marked

\*Read before the National Electric Light Association meeting at Pasadena, Cal., May 20, 1920.

decrease in sulphur and an increase in transverse strength. At present, because of costs, the process appears adaptable only for the very highest grade of castings. The electric furnace is also being used for the production of malleable iron castings. It has furthermore been considered as a mixer for keeping molten blast-furnace pig iron hot for casting it into pipes in ingots.

### STEEL

The most marked increase in the use of central station power electric furnaces during the past ten years has been in the electric-furnace manufacture of steel. In 1904 there were four small furnaces in operation in Europe. In 1907 there were sixty-seven furnaces in operation throughout the world. Of this total, seven were installed in the United States and Canada, with a total power input of 5,600 kva. and a charge capacity of forty tons per heat. On Jan. 1, 1920, there were installed or under construction in the United States and Canada 363 furnaces with a total charge capacity per heat of about 1,600 tons and a total power input of about 600,000 kva. Of the 363 furnaces, 323 were installed in the United States and 40 in Canada. The number of electric steel furnaces in the world is estimated at 875.

The production of electric-furnace steel in the United States in 1918 was 511,364 gross tons. Almost 50 per cent of the production was alloy steel. Of the 323 furnaces in this country 54.5 per cent are being used for castings. The percentage of the tonnage of 1918 produced as castings was 21.1 per cent of the total.

There has been a great development in the use of the electric-steel furnace for the production of ingot alloy steels for automobile construction and high-speed steel. The electric furnace operating with a basic lining produces tons of high-grade alloy steels per heat as compared with the crucible furnace producing pounds. Lower grade raw materials can be used because of the possibility of refining to remove phosphorus and sulphur. The furnace has proved particularly successful in the production of alloy ingots such as chrome : vanadium steel, turning out a product better in quality than similar open-hearth steel with a much lower loss of alloys by oxidation.

For the production of high-speed steel in large heats the electric furnace proved well adapted during the war, it being common practice to pour 5-ton heats of steel valued at \$3 to \$5 per lb. However, the substitution of the electric furnace for the crucible furnace will be gradual, because it is not yet demonstrated that average electric high-speed steel is quite equal in quality to the highest grades of crucible high-speed steel. To meet the grade of highest quality crucible steels, the electric-furnace product must be made from the purest raw material available, and even then, considering electric steel versus crucible steel from the conditions existing in each case, it does not seem possible that melting conditions can be as closely controlled in the electric furnace as in the crucible. This statement applies only where the operation is the simple melting of pure material.

A future probable large development in electric steel is the use of the furnace for finishing molten converter and open-hearth steel. The Illinois Steel Co. has installed ten 30-ton electric furnaces to treat steel which has been first blown in the bessemer converter, then held in the open hearth, and eventually transferred to the

electric furnace. This process was used to a small extent in the early days of electric furnace steel production in this country, and a few years will probably see its general adoption.

### ELECTRIC STEEL CASTINGS

In 1910 of the total production of electric steel in this country 2.53 per cent was as castings. In 1918 there was manufactured 108,296 tons of electric steel castings, representing 21.1 per cent of the total production of electric steel. Except for the manufacturers of high-speed steel, most companies producing alloy steels, such as chrome : vanadium steel, generate their own power, and do not buy from a central station, because the electric-furnace plant is usually a part of a large steel plant. This is especially true in plants using the duplex process for refining molten steel. On the other hand, practically all foundries buy their power. Electric-steel castings can now be made more cheaply than converter castings, and at as low a cost as open-hearth castings. The grade of the casting is better than the product of either of the other methods.

A great advantage of the electric furnace over the open hearth is the rapidity with which heats are made, so that it does not require handling of large quantities of metal as in the case of the open hearth. Within a few years the electric furnace will probably replace all other processes for making steel castings, and most castings will be produced without refining, by melting scrap on an acid bottom.

Aside from the fact that the skill shown in furnace operation may cause a low load factor, most foundries operate on a 10-hr. day instead of a 24-hr. day, so that with 10-hr. operation a load factor of 18 to 30 per cent is obtained. On a 24-hr. day the load factor will vary from 40 to 55 per cent when making castings. This low load factor, as compared with other electrometallurgical industries, is caused by time lost in charging and pouring when the power is off. Due to greater length of time between pourings, a furnace producing ingots on a basic bottom with refining should have a higher load factor than those mentioned, but this is offset by the present common practice of running with about half or one-third load during the refining period at the end of a heat. A furnace refining molten steel instead of melting cold scrap should attain a load factor of 75 per cent on 24-hr. operation.

The power consumption varies from 550 kw.-hr. per ton when melting scrap on an acid bottom for castings to 1,000 kw.-hr. per ton when making high-speed steel ingots requiring refining. The voltage on the only type of single-phase furnace now used is about 140 volts on the arc, 220 volts open circuit. On two- and three-phase furnaces the voltage is from 90 to 110 volts. The power factor of the single-phase furnace mentioned varies from 50 to 70 per cent due to heavy reactance in the circuit. The two- and three-phase furnaces have power factors of from 85 to 95 per cent. The electrode consumption is 15 to 25 lb. per ton of steel.

### NEW TYPES OF FURNACES BASED ON THE ORIGINAL HEROULT FURNACE

During recent years the tendency in electric-steel furnace construction has been to increase the power input per ton; to use three-phase current and automatic regulators; not to have large reactances in the primary circuit; and not to build furnaces with a bottom electrical



connection, at least a connection carrying all of the load. In fact, now that the basic Heroult patents have expired, most new types of furnaces appear to be the original Heroult furnace embellished and camouflaged, which is probably a good thing. The power input per ton of charge has been increased from 170 kw. in the early furnaces to 500 kw. in the most recent steel-casting furnaces. One furnace has been built with electrical connection permitting cutting the secondary voltage in half during refining. The use of three-phase current has become almost standard either as three-phase current in the furnace or three-phase converted to two-phase. Few single-phase furnaces are being built. The single-phase furnace with the bottom contact, however, blazed the way for rapid melting of scrap for steel castings on an acid bottom and the use of heavy power input per ton of charge.

The use of heavy reactance in the circuit is being discarded with few exceptions, and furnaces are generally operated with a moderate reactance and automatic regulators. Common reactances are 7 per cent to 15 per cent in the transformer. The bottom contact, as used for carrying all of the current, has apparently gone out of use with the gradual abandonment of single-phase furnaces, although it is still used for putting a small part of the current through the bottoms of some two-phase and three-phase furnaces.

The furnace with a moderately high power factor, 80 to 85 per cent, has proved to be a better load for the central station than the furnace with a very high power factor, 95 per cent, because it is not so sensitive to short circuits in the furnace, and at the same time there is enough reactance present to render electrode regulation easy with regulators. The use of furnaces with heavy reactances and hand regulation of electrodes should be discouraged, as the heavy reactance is not necessary if regulators are installed.

#### ELECTRICAL HEAT TREATING

Electric furnaces of the carbon resistance type have been installed in considerable number for the heat treatment of forgings and castings. The furnaces are ingeniously designed with a very complete automatic control of temperature, and control movement through the furnace of the piece being treated. The heating is by a resistor of granular carbon confined in carborundum fire sand troughs, which results in a uniform load without surges and a power factor of 98 per cent or better. The load on the furnace is controlled by variation of secondary voltage with taps on the secondary of a special type of transformer. The electric heat treatment of steel is certain to become common practice even at a higher cost because of the ease of control and uniformity of the results obtained. Single-phase furnaces of 900 kw. power input have been installed alone or with two or three connected in balance on a three-phase circuit and operated successfully. A further advance is the adaptation of this type of electric furnace to the soaking pit for large steel ingots and billet reheating furnaces.

Another type of electric heat-treating furnace was developed during the war, in which the heating unit consists of a nickel:chromium alloy ribbon mounted on a cast-iron supporting plate and insulated therefrom by suitable refractory material. The furnaces are of the cylindrical, vertical type and take three-phase 440-volt current. Units of 400-kw. capacity have been built. The current is automatically thrown off and on as the

temperature rises above or falls below the desired point. These furnaces were designed for the heat treating of gun barrels, but can readily be adapted for the industrial uses of the future.

#### FERRO-ALLOYS

The war demand brought the electric-furnace ferro-alloy capacity to a point which, with the arrival of a more normal peace demand for ferro-alloys, puts the industry in much the same condition as existed in the European calcium carbide industry in 1899, when overproduction and patent litigation compelled most plants to look for new products, which strangely proved to be ferro-alloys. The increase of installed furnace transformer capacity for ferro-alloy production was enormous from 1915 to 1918. In 1910 there were only two plants in the United States which produced ferro-alloys in the electric furnace. They had a total transformer capacity of possibly 20,000 kva. On Jan. 1, 1920, there were forty plants with a combined transformer capacity of 200,000 kva. At the date of discussion, probably 75 per cent of these plants are not operating.

With the enormous increase in plant capacity the United States easily led the world in production of ferro-alloys when the armistice was signed. The plant capacity of ferrosilicon has increased from 10,000 or 15,000 tons per year to 100,000 tons per year. Instead of importing ferrotungsten and ferrochrome, large quantities were exported. Ferrovandium, which had always been exported, was shipped abroad in larger quantities than ever. But the two most important developments have been the electric smelting of manganese ores and the increased use of molybdenum in steel.

In 1914 there were no electric smelting plants built for production of ferromanganese. On Armistice Day there were ten plants of total transformer capacity of 55,000 kva. and production capacity of about 80,000 tons per year. At the close of 1918 about 15 per cent of the ferromanganese production of the United States was being made in electric furnaces. With two exceptions these plants are now out of operation, the two largest having resumed work when the price of ferromanganese advanced several months ago.

Through the interest of one of the largest smelting companies in the world in a Colorado molybdenite deposit, which is probably the most extensive known deposit of molybdenite, containing at least 100,000,000 tons of 1 per cent ore, large-scale investigation of the use of molybdenum in steel has resulted. This work shows that the addition of small quantities of molybdenum to chrome, nickel, chrome:nickel or chrome:vanadium steel results in a steel of greater strength and toughness, which is easily forged, easily heat treated and easily machined. Probably 300 tons of ferromolybdenum were produced in 1918 as compared with less than twenty-five tons in previous years. There was a very small production in 1919.

Practically all ferrosilicon furnaces are now installed in three-phase units. If it is desirable to install units of less than 1,500 kva. capacity, a single-phase furnace with two vertical electrodes in series is usually built. There is at least one plant in this country equipped with single-phase furnaces of this type. All of the large ferromanganese furnaces erected in this country are of the three-phase type. The ferromanganese furnace gives about the smoothest and most easily controlled load of any of the ferro-alloy furnaces.

Ferrochrome is made in both single-phase furnaces



and three-phase furnaces. Before the war an engineer from the largest point of ferro-alloy production, Niagara Falls, claimed that ferrochrome could not be made in a furnace of over 1,000-kw. capacity. This was proved to be a fallacy by the recent installation of a 1,500-kw. furnace in Denver which operates more satisfactorily than a smaller furnace at the same plant.

Ferrotungsten is almost universally made in the single-phase furnace of the Siemens type with the bottom forming one electrode. The metal is allowed to build up in the furnace and the furnace torn down to remove it. This results in considerably more irregular load curve than with the larger tapping furnaces. One plant, now dismantled, successfully made ferrotungsten in a three-phase furnace.

The characteristics of ferromolybdenum operation are much the same as for ferrotungsten, except that when the 55 per cent molybdenum alloy is being made, it can be produced in a tapping furnace instead of a knock-down furnace.

Electric furnace ferrovanadium is usually produced in a single-phase furnace, either of the Siemens type or series type.

Ferro-uranium is made in small furnaces of the Siemens type. Due to absence of slag in the operation, the load is very irregular, and considerable reactance is usually used in the circuit, especially if automatic regulators are not used. The load characteristics of a ferrotitanium furnace are somewhat similar to those of ferro-uranium.

In commercial production of these ferro-alloys, ferro-silicon, ferromanganese and ferrochromium can be made in three-phase furnaces as readily as in single-phase furnaces, and there is no reason for permitting installation of single-phase furnaces for their production. Ferrotungsten, ferromolybdenum, ferrovanadium, ferro-uranium and ferrotitanium must be made in single-phase furnaces. At least the operation is much more apt to succeed in a business way. It may be noted that the line of division in these alloys is between metals of a low melting point and metals of a high melting point. Silicon, manganese and chromium have comparatively low melting points when electric-furnace temperatures are considered, while the melting point of tungsten, molybdenum, vanadium, uranium and titanium is high.

Some power companies seem to have an idea that electric ferro-alloy furnaces can run on any old voltage. If possible an endeavor should be made to deliver power at a constant voltage throughout the twenty-four hours of a day. Recently I put in operation a ferro-alloy plant with the understanding that the primary circuit was 4,500 volts. Furnace transformers were installed with a ratio of 4,500/75. During the twenty-four hours the secondary furnace voltage varied from 72 to 85 volts, depending on whether the industrial load of the town was on or off. This results in two things—it ran up the demand charge, because the furnace would run at the same amperage with higher voltage unless watched continuously, and means the production of a poorer grade of metal when running a knockdown furnace, as the button will not be so compact with high voltage. The difficulty was not caused by anything in the furnace transformer, which had a reactance of 7 per cent, as the same ratio of variation was shown on the 110-volt lighting circuit. In another case a large furnace was installed on a power line which the power company

claimed was more than heavy enough. It resulted in a line drop of 25 per cent, which made the furnace voltage so low that enough power could not be got into the furnace to keep it hot. Ferro-alloy furnaces are run on certain voltages because practice has proved these voltages to be the best. Of course, in 3,000 to 4,000-kw. furnaces it is necessary sometimes to raise the voltage above the desired limit for good metallurgical practice in order to get power into the furnace.

The electric-smelting load, at the present time exemplified by ferro-alloy furnaces, is probably one of the best loads a power company can get, and in the future may prove a much larger load with application of electricity to smelting of non-ferrous ores, which is not such a dream as it may seem at present.

#### BRASS

There has been a remarkable growth of the use of the electric furnace for melting brass and non-ferrous metals. From one silver-melting furnace of the carbon resistor type in 1914 the number has grown to 261 on March 1, 1920. Of these furnaces 61 are carbon resistor furnaces, 118 are induction furnaces and 82 are arc furnaces of various types. Furnaces are being used to melt brass castings, wrought brass, bronze, copper and nickel. The total estimated installed transformer capacity is 23,000 kva., of which one-third is on carbon resistor furnaces, one-half on arc furnaces, and the remainder on induction furnaces. The carbon resistor furnaces operate at 98 per cent power factor, giving a very steady load. The most common size has 105 kva. transformer capacity. The induction furnaces are built in the smallest units of any of these furnaces, taking 30 to 60 kw. load with a power factor of 70 to 85 per cent. The indirect rotating arc furnace operates at 80 to 90 per cent power factor, and is built in sizes up to 300 kva. Depending on the kind of brass being melted, the power consumption varies from 250 to 400 kw.-hr. per ton. All of the brass furnaces are single phase except one type of three-phase furnace which has not been widely installed for this purpose.

#### ZINC

Although there has been considerable experimenting in the United States and Canada during the past ten years on electric smelting of zinc ores, nothing has been done in commercial production. Electric smelting of zinc ore and dross has been practiced commercially in Sweden since 1901. Two plants are in operation in that country, with a total transformer capacity of 15,000 kva. A large part of this capacity has been used for smelting dross. When smelting ore the main difficulty has been in production of blue powder instead of zinc. Single-phase furnaces of 350 to 750 kva. size are used. Although the blue powder difficulty appeared practically solved by experimenters in the United States several years ago, nothing commercial has resulted. Electric smelting of zinc ore in the United States will possibly at some time be accomplished in a commercial plant. It is much better adapted to operation in small units for isolated mines than the electrolytic process.

A large 1,000-kw. melting furnace of the carbon resistor type was put in operation in 1919 for melting the zinc cathode in an electrolytic zinc plant. In the first weeks of operation it is reported that the furnace melted zinc with a power consumption of 70 to 80 kw.-hr. per ton of metal, and a metal loss in dross of 0.024 per cent.

In addition to the cheapness of the power, the character of the power contract negotiated and the basis of figuring rates will have some effect on the efficiency of operation of the electric furnace. I believe that electric furnaces, particularly smelting furnaces, are operated at their highest efficiency under contracts which provide for a flat charge per kilowatt-month, based on the maximum demand, rather than a charge which includes a maximum demand charge and a kw.-hr. charge. Under such a contract the furnace operator is compelled to install small units for a continuous operation of twenty-four hours per day rather than a large unit to be operated only ten hours per day. In the end it means a better load for the power company, and will probably mean money saved for the furnace plant. Under such a contract the power company is protected to the extent of its overhead charges by the minimum guarantee payments if the plant should not be operated continuously. Under such a contract I have operated plants in which the process was intermittent at a load factor of 70 per cent, and in plants where a continuous process was being used have run at an average load factor of 85 per cent.

In the contract under which I have operated, the power factor must be over 75 per cent, and the maximum instantaneous demand cannot exceed 300 per cent of the normal rate. The power company also requires that the load on any one phase shall not exceed the load upon any other phase by more than 15 per cent. There has been no difficulty in meeting these requirements.

#### FUTURE DEVELOPMENT

In melting steel and non-ferrous metals and electrolytic refining of metals a power cost of 1c. per kw.-hr. is reasonable, but a smelting process or electrolytic reduction process, except when producing the high priced ferro-alloys, such as ferrovanadium, cannot stand this price. The smelting-furnace operator does not expect the two-mill power of Sweden, but in most cases he must have five-mill power. The present cost of power limits the following electrometallurgical processes to hydro-electric power: the smelting of iron ore, ferro-alloy production, aluminum, electrolytic zinc precipitation and the electric smelting of non-ferrous ores.

The price of coal and oil has reached such a point in many Western smelting centers, where hydro-electric power is available, that if electric furnaces were developed to a point where they could be substituted for combustion furnaces, substitution of electric furnaces would undoubtedly result. This development is certain to come before many years if fuel prices remain high, particularly oil.

Modern industry demands high-grade products. Even if electric-furnace steel costs slightly more than open-hearth steel, the requirement of the best steel possible for present-day industrial purposes is certain to result in a large increase of the production of electric-furnace steels and non-ferrous alloys. This will eventually increase the consumption of electrically produced ferro-alloys.

In summary, a considerable increase of the uses of electricity is to be eventually expected in the following processes: (1) iron castings from scrap or a duplex process of cupola melting with electric-furnace refining; (2) steel castings and alloy steels; (3) ferro-alloys; (4) aluminum; (5) brass melting; (6) electrolytic zinc; and (7) electric smelting of non-ferrous ores.

## The National Bureau of Standards

THE National Bureau of Standards was created on March 3, 1901, by an act of Congress. It is charged with the development, construction, custody and maintenance of reference and working standards and their intercomparison, improvement and application in science, engineering, industry and commerce. Besides the standards of measurement, such as standards of length, volume, heat, light, electricity, etc., there are standard constants, an example of which is the mechanical equivalent of heat; the standards of quality, as exemplified by specifications; standards of performance,



U. S. BUREAU OF STANDARDS BUILDINGS

such as the ratings of engines, boilers, dynamos and other machines, and standards of practice, which include the various building and safety codes, etc.

#### DIVISIONS OF THE BUREAU

For purposes of organization, the bureau is divided into nine scientific divisions, as follows: Division of Weights and Measures; Electrical Division; Division of Heat and Thermometry; Optical Division; Chemistry Division; Division of Engineering Physics; Division of Structural, Engineering and Miscellaneous Materials; Division of Metallurgy, and the Ceramics Division.

#### ITS WAR-TIME ACTIVITIES

While the application of science to the industries was recognized by a few of the more advanced manufacturers in this country, its importance to our national life was not generally realized until the war had been in progress for some time. It was then found that science was a very practical proposition without which it was impossible to make any headway. The detection of airships and submarines, the location of hidden guns, the manufacture of substances the supply of which was cut off, were a few of the problems put up to the scientist by the military departments. The Bureau of Standards suddenly found itself the center of a vast number of activities which required a great increase in its personnel and equipment.

Supremacy in peace is no less dependent upon science and standardization, and this should not be lost sight of at this time when the tendency to revert to old times is so great—what we have gained we should hold.



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## Legal Notes

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BY WELLINGTON GUSTIN

### **Seller Must Prove Product Possessed Quality Desired Where Such Is Known to Him**

In the case of the James K. Thompson Co. against the International Compositions Co. judgment for the former was reversed and new trial granted by the New York Supreme Court, Appellate Division.

The plaintiff Thompson company sued on contract for the price of a quantity of copper oxide. The oxide was sold for the specific purpose of making a high-grade anti-fouling marine paint. The seller knew that there was required for the work a very fine grade of copper oxide, and the first two deliveries were fully up to the standard required by the buyer. However, the third delivery was claimed to have been much coarser. There were foreign substances in it and it would not pass through the fine sieve that the other oxide delivered would pass through. The buyer claimed this violated the requirements of the contract of sale. But before discovering the defect in this article it had used about one-third of this defective third shipment, and in making paints therefrom it made paint utterly useless and which was returned by its patrons, and the buyer claimed damages by reason of the loss of other materials that it put into the paints which were thus rendered unsalable by reason of the defective copper oxide, such damages amounting to double the seller's claim.

The rule of law is laid down that the seller, having knowledge of the fine quality of oxide required by the buyer for the making of marine paint, has the burden of showing that he furnished the required quality. And the defendant, urging a counterclaim, has the burden of proving same.

### **Indorsement on Check Insufficient to Discharge Whole Claim in Dispute**

The Supreme Court of Errors of Connecticut has reversed the judgment obtained by the defendant Premier Manufacturing Co. in the suit brought against it by the Crucible Steel Co. of America, and ordered judgment for the latter.

Crucible Steel brought its action to recover for goods sold and delivered under five separate invoices. There was no dispute concerning the first three. The two others were in dispute because it was claimed the products had been shipped from Pittsburgh instead of New Haven, Conn., as ordered, and that the goods were not received. Defendant sent its check for the undisputed items. Subsequently this action was brought to recover for the two items remaining unpaid together with some incidental charges. The Premier company defended on grounds of accord and satisfaction and that it had never received the merchandise. The trial court found the Premier company had received the merchandise, that it had paid for the incidental and other charges against it, but gave it judgment on the issue of accord and satisfaction, as shown by payment of its check. On back of the check were the words "In full settlement of invoices to date," etc.

In tendering the check the Premier company intended

to pay its entire indebtedness to the Crucible company according to the former's understanding of it, and to settle thereby all matters in dispute with the Crucible company up to the date of the check. The latter accepted the check, gave credit on its books for the invoices listed on the back of the check, and continued to bill the Premier company for the other invoices and items charged against it.

Commenting on the defense that acceptance of the check was an accord and satisfaction of the disputed account, the Supreme Court said the defense of accord and satisfaction requires the defendant to allege and prove a new contract based upon a new consideration, and there must be a meeting of the minds of the parties, and the new consideration must be offered by the debtor and accepted by the creditor with intent to satisfy the whole claim, and the fact that such sum is offered in discharge of the whole claim must be made known to the creditor in some unmistakable manner.

Further, the court held that the memorandum on the back of the check was insufficient to express clearly the condition that, if accepted, it must be accepted in satisfaction of the entire amount claimed by the creditor on five separate invoices, thereby precluding the Crucible company from suing for the balance.

### **Fraudulent Representations Do Not Make Fertilizer Fraudulent Under Statute**

The Supreme Court of Louisiana has reversed the judgment of the lower court in the action by the Planters' Fertilizer & Chemical Co. against Barton & Barton, ordering judgment be entered in favor of the chemical company for \$5,719.15 with 6 per cent per annum from June 22, 1913, and that costs of the suit also be paid by Barton & Barton.

The company sued for the price of fertilizer sold Barton & Barton as per contract. The defense was that the agent who negotiated the sale for the chemical company represented that the fertilizer would contain 8 per cent ammonia in the form of either cottonseed meal or tankage, whereas it contained ammonia in neither of these forms, and proved to be valueless for the purposes sold, and that it was fraudulent within the statute.

Now, this Act 126 absolves the purchaser of fraudulent fertilizer from having to pay for same; but the fertilizer was not in itself fraudulent, said the court, being an honest article of commerce and duly inspected by the official fertilizer inspector and found to conform to all the requirements of law. It did not accord with the representations which defendant said the sales agent made, but which the agent denied having made; but this did not render it fraudulent. The representations, if made, might have been fraudulent, without the fertilizer itself being so, said the court.

The contract called for "planters' cane fertilizer No. 8, 8 per cent ammonia," with nothing said as to the kind of ammonia. Moreover, it contained the clauses that the fertilizer "is purchased without any guaranty from the chemical company or its agents as to results from its use," and that "no agreement not expressed in this contract shall be binding" upon the company.

The company showed that "planters' cane fertilizer No. 8, 8 per cent ammonia" was manufactured according to advertised formula, was on the market as such, and that the article sold to Barton & Barton conformed to the formula.



## Synopsis of Recent Chemical & Metallurgical Literature

**Distribution of Phosphorus Between  $A_c$  and  $A_{c_2}$ .**—J. H. Whiteley, of Stockton, England, read a very interesting and important paper upon this subject before the British Iron and Steel Institute May 6, 1920. Experimenting on steels listed in Table I, he found that after normalizing any of these at 1,300 deg. C. a uniform distribution of all elements which are affected by the copper reagent was had. If, now, one of these normalized samples, such as E, be heated for one hour at 810 deg. C. and then quenched, it would appear as Fig. 1 after etching with picric acid. The striated areas evidently represent the patches of martensite, and the light areas represent the patches of ferrite existing in equilibrium with austenite at 810 deg. C., which is within the transformation range for that steel. Etching with a copper reagent merely accentuates the contrast between light and darker areas.

The author recommends that a polished specimen, etched with picric acid, be repeatedly dipped in a reagent (containing 0.04 g. of copper oxide dissolved in 6.0 c.c. of strong nitric acid and made up to 200 c.c. with methylated spirit) until a bluish coating appears. Then remove the copper by rubbing the surface lightly with the finger under running water and repolish the surface on a wet cloth free of polishing powders. Repeated etchings bring out very delicate contrasts. Sharp contrasts can also easily be had by following one such etching with the usual Stead's reagent.

If Fig. 1 be heated *in vacuo* at 680 deg. C. for fifteen minutes, and etched with the copper reagent noted above, the structure shown in Fig. 2 is revealed at the same spot. Evidently, light areas represent location of alpha iron existing at 810 deg. C. poor in carbon and rich in some other element "X." If only carbon were responsible the dark areas in Fig. 2 would be smaller than in Fig. 1, rather than larger.

Similarly, quenching from various temperatures between  $A_c$  and  $A_{c_2}$  showed that a redistribution of "X" and carbon occurs at any temperature within the transformation range. The white areas naturally diminish relatively as the temperature rises, since the volume of austenite holding carbon in solution increases in volume with increasing temperature.

Figs. 3, 4 and 6 show the appearance of sample G, after various temperings at 740 deg. C. Since carbon has been shown to

diffuse very rapidly, "X" appears to require four hours to reach equilibrium at 740 deg. C. The same effect occurs quicker at higher temperatures, but in this case the white areas are smaller, due to a larger relative volume of austenite. Diffusion below  $A_c$  is very slow, since twenty hours at 660 deg. C. is required to give fuzzy edges on the white spots of Fig. 6.

By etching carefully to bring out relief in the dark areas, such as in Fig. 4, it was found that the diffusion of "X" is quite rapid in gamma iron. Uniform distribution of "X" in gamma iron requires only fifteen minutes at 840 deg. C., but even so is not as rapid in diffusion as carbon (Fig. 5).

When annealing above  $A_c$ , "X" diffuses very much slower, requiring 1,000 deg. C. before it reaches the rate attained at 860 deg. C. The author cites this as evidence that the martensites produced by quenching from temperatures a little below and a little above  $A_c$  are not physically identical.

Evidence that the white spots in Fig. 6 are really due to phosphorus was had by studying compositions of various steels. For instance, in sample A, after having been heated several hours at 820 deg. C. and etched, only the pearlitic areas and grain boundaries could be seen. Samples B and C, after one hour at 820 deg. C., gave the same appearances as steels D and E, but less pronounced, the gamma iron areas being etched less deeply.

If the white spots represent high P concentration in

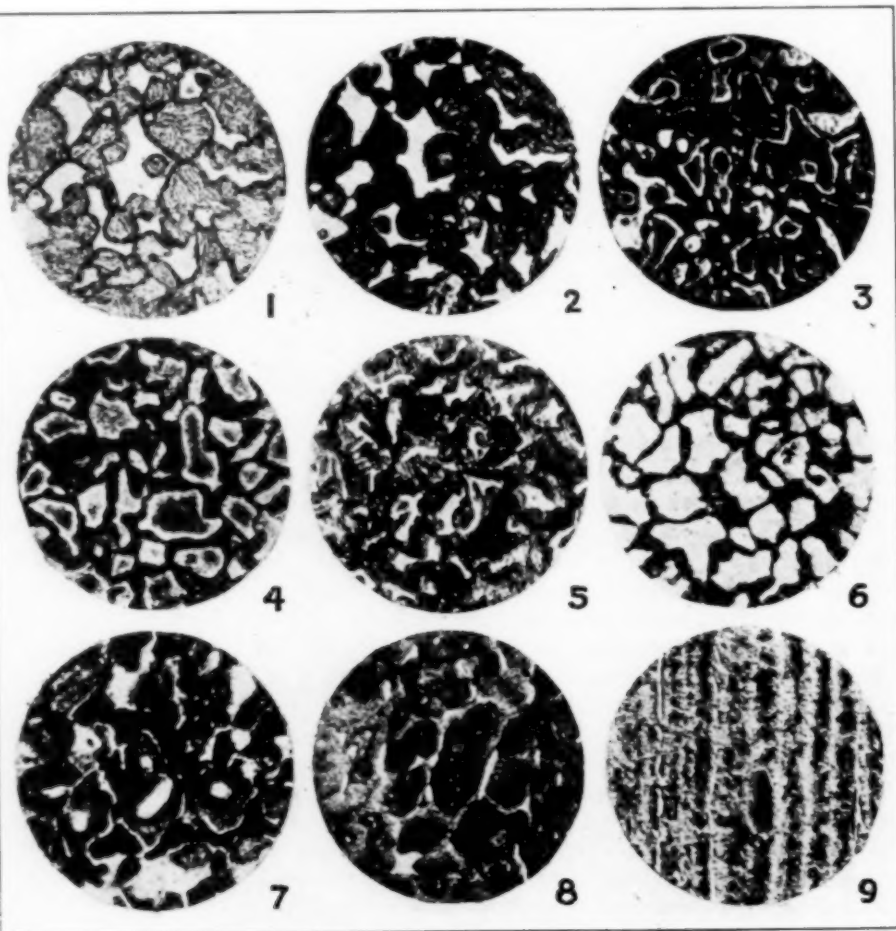


Fig. 1. Sample E. 1 hr. at 810 deg. C. and quenched.  $\times 420$ .

Fig. 4. Sample G, after 1 hr. at 740 deg. C.  $\times 400$ .

Fig. 7. Sample G, after 1 hr. at 840 deg. C. and 15 min. at 740 deg. C.  $\times 440$ .

Fig. 2. Same as Fig. 1, tempered at 680 deg. C. for 15 min.  $\times 420$ .

Fig. 5. Sample G, after 1 hr. at 760 deg. C. and 5 min. at 830 deg. C.  $\times 440$ .

Fig. 8. Sample G, slowly heated to 830 deg. C. and held there 1 hr.  $\times 400$ .

Fig. 3. Sample G, after 15 min. at 740 deg. C.  $\times 400$ .

Fig. 6. Sample G, after 4 hr. at 740 deg. C.  $\times 400$ .

Fig. 9. Sample G, as rolled and 2½ hr. at 855 deg. C.  $\times 135$ .

TABLE I. ANALYSES OF SAMPLES USED IN THE EXPERIMENTS

No.	Description	Per Cent							Tempera- ture of Reversal, Deg. C.	Carbon Content of Gamma Iron at This Temperature Per Cent
		C	Si	P	S	Mn	Cu	A		
A	Basic open-hearth steel plate.....	0.11	0.04	0.006	0.023	0.29	0.012	0.004		
B	Basic open-hearth steel plate.....	0.155	0.025	0.01	0.027	0.48	0.083	0.10	810	0.35
C	Basic open-hearth steel plate.....	0.16	0.03	0.014	0.038	0.57	0.06	0.044	810	0.35
D	Basic open-hearth steel plate.....	0.18	0.04	0.027	0.039	0.45	0.054	0.065	780	0.45
E	Acid open-hearth steel plate.....	0.185	0.015	0.061	0.075	0.52	0.086	0.054	770	0.50
F	Basic Bessemer steel billet, 2-in. square sec- tion.....	0.06	tr.	0.104	0.112	0.56	0.026	0.072		
G	Basic open-hearth steel plate.....	0.18	0.04	0.12	0.055	0.51	0.067	0.026	740	0.75
H	Case-hardened electrolytic iron.....	0.20		0.002		none				
I	Steel.....			0.06		tr.				

alpha iron, then the percentage of phosphorus must be higher in low-carbon steel to show the same etching differences because they could contain a larger volume of ferrite—a consideration checked by experiment. Time, temperature and concentration affect the size and appearance of the white areas exactly as they should if they were due to some diffusible substance contained therein.

Analyses given in Table I make it clear that whereas the contrasts developed by the copper reagent vary directly with the phosphorus contents, none of the other elements show parallel differences. For instance, silicon is very low in all samples. Copper in samples B and G is about the same, yet there is a marked difference in etching effects. Manganese was absent in sample H and was present in quite considerable amount in sample A, yet the action of the cupric reagent is very similar. Samples B and G are about equal in manganese, yet the reagent brings out extreme differences. Copper in B is seven times as much as in A, yet the cupric reagent acts about the same in these cases. B, again, is higher than sample G in copper, whereas the latter shows pronounced contrasts under the reagent. As for arsenic, G contains one-quarter as much as B and A contains one-twenty-fifth as much as B, proportions which may not be harmonized with the experiments.

It is possible that "X" is some element not usually analyzed for. Mr. Whiteley notes that a  $\frac{1}{2}$ -g. piece of G was heated four hours at 1,000 deg. C. in dry hydrogen, cooled in the furnace, then heated one hour at 840 deg. C. in dry hydrogen, a procedure thought to remove oxygen effectively, yet the resulting structure after etching was entirely similar to Fig. 6.

If samples are quenched after a long time near  $A_c$ , ferrite is likely to etch more quickly than the martensite, since the latter contains such high carbon that its solution pressure is less than the low-phosphorus ferrite. If this same sample is air-cooled, etching reverses, since then there is no cementite in solution. There is a temperature where the etching figures reverse, as tabulated under "Temperature of Reversal." This is evidently the temperature where the solution pressure of alpha iron containing P equals that of austenitic material. Phosphorus has been previously equalized by high-temperature normalizing; therefore it would require a diffusion and divorce of carbon and phosphorus to reverse these etching figures, since martensite otherwise would always etch less than iron containing no carbon in solid solution.

Fig. 7 shows small white spots locating high-phosphorus areas at 840 deg. C and white markings outlining the volume of ferrite existing at 740 deg. C. Phosphorus appearing in the lower temperature ferrite is coming from the surrounding black portion—that is, from gamma iron—more rapidly than from the en-

closed white portion. Phosphorus, as well as carbon, is more soluble in gamma iron at higher temperatures, but the solubility of phosphorus is less if the austenite is saturated with carbon at the high temperatures. Therefore phosphorus is not completely insoluble in gamma iron.

In all the experiments, small samples were heated very rapidly, requiring only two or three minutes. When heating at 4 deg. per min. above 700 deg. C., followed by air cooling, all the structures developed were the same up to 815 deg. C. Fig. 8 shows the cellular structure developed by slow heating and soaking at temperatures higher than 815 deg. C., then quenching or air-cooling. Time required to develop this structure varies inversely as the temperature above 820 deg. C. If the phosphorus has not previously been entirely equalized, cellular structure is found after a rapid heating. Soaking at high temperature and slow heating seems to be essential for cellular structure in previously normalized samples. Phosphorus is responsible for this phenomenon, because it could not be developed in sample A and increased in contrast and ease in formation as phosphorus increased. The temperature required to form the structure increases with the amount of carbon in the steel, consequently it can be developed only in steels of very low carbon contents. Much further work is required before these and other points in connection with the subject can be elucidated.

Micro-ghostlines shown in rolled plate by copper reagents have ordinarily been ascribed to phosphorus. That they remain after heat treatment has been explained by the slow diffusion of phosphorus, but it has herein been shown that phosphorus migrates rapidly within the transformation range. Samples A to E in their rolled condition were heated for two and one-half hours at temperatures slightly below  $A_c$ , which would certainly have equalized phosphorus in the gamma iron. Fig. 9 shows sample G after such heat treatment; ghostlines are still present. If rolled plate is heated slowly to 900 deg. C., a cellular structure is developed, but the cells are ranged parallel to the direction of rolling. It is therefore evident that the micro-ghostlines are not entirely due to the heterogeneous distribution of phosphorus. To account for these ghostlines it seems necessary to infer the presence of some other substance which diffuses with extreme slowness at temperatures below 950 deg. C., but with greater rapidity at 1,000 deg. C.

**Reconstruction Status of the French Industries.**—The official report of the French Industrial Reconstruction Bureau states that the activities in the devastated area are progressing quite satisfactorily. This, of all the plants in operation in 1914, employing 729,185 workmen, about 77 per cent were already in working condition July 1, 1920, employing 307,185 workmen. (*La Technique Moderne*, September, 1920.)



## Recent Chemical & Metallurgical Patents

### American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

#### Production of Chlorides of Zinc From Zinc Ores.—

A method of preparing zinc chloride and the double chlorides of zinc with the alkali metals from zinc sulphate is described by F. K. CAMERON, J. A. CULLEN and R. W. HYDE. The object of the invention is to obtain this salt by a simple and economical process from zinc ores. Zinc sulphate is prepared by roasting oxide ores of zinc with sulphuric acid and subsequently leaching the product. The resulting solution is treated for the removal of impurities. Sodium chloride is added in excess and the solution is evaporated to a density of about 55 deg. Bé. Upon cooling the concentrated solution sodium sulphate will crystallize out and can be separated from the mother liquid. The solution is concentrated to a density of about 60 deg. Bé. and upon cooling a double salt of the composition  $\text{ZnCl}_2 \cdot 2\text{NaCl} \cdot 3\text{H}_2\text{O}$  will separate as pure crystals. In case insufficient sodium chloride was added the salt  $\text{ZnCl}_2 \cdot \text{NaCl} \cdot 3\text{H}_2\text{O}$  will separate upon cooling. If to the double salt a solution containing 30 per cent or more hydrochloric acid be added and the mixture be agitated, sodium chloride will separate. The filtrate can be freed from hydrochloric acid by heating and upon evaporation pure zinc chloride can be obtained. (1,352,399; assigned to the American Smelting & Refining Co.; Sept. 7, 1920.)

**Aluminum Casting Alloy.**—THERON D. STAY, of Cleveland, Ohio, has found that an aluminum alloy containing 10 to 12 per cent copper and 0.1 per cent or less titanium is especially adapted for the production of castings in which the metal is irregularly distributed as to bulk, but which must possess good machining and bearing qualities. The process of making the alloy is divided into four stages: (1) The production of an alloy containing about 82 per cent copper, 12 per cent aluminum and 6 per cent titanium in an electric furnace, titanium oxide being reduced by an excess of aluminum; (2) the production of an alloy containing about 52.1 per cent aluminum, 46.5 per cent copper and 1.4 per cent titanium by melting 100 parts of the alloy made as in (1) and 100 parts of copper in a graphite crucible and adding to the molten metal 50 parts of an aluminum alloy containing 3 per cent copper; (3) production of an alloy containing equal parts of copper and aluminum in a crucible furnace, and (4) production of the desired alloy containing 88 to 90 per cent aluminum, 12 to 10 per cent copper and 0.1 per cent titanium or under, from proportional amounts of the alloys obtained in (2) and (3), aluminum and scrap alloy, melted in a crucible. By producing the final alloy in this way only a relatively small amount of alloy has to be produced in an electric furnace at a high temperature and a minimum amount of metal has to be heated to the high temperature necessary to melt copper. (1,352,322; assigned to the Aluminum Castings Co.; Sept. 7, 1920.)

**Use of Sulphur Dioxide as a Reducing Agent in the Electrolysis of Copper Solutions.**—In the electrolysis

of solutions obtained by leaching copper ores with sulphuric acid the current efficiency is decreased by the presence of ferric iron, ferrous iron being without appreciable effect, and the low current efficiency is one reason why hydrometallurgical processes are not extensively applied to copper ores. It is necessary, at plants in operation, to remove the copper from a portion of the solution by some other method than electrolysis, usually by precipitation on scrap iron, otherwise the accumulation of iron salts through the cyclic use of solution would make continued operation impossible. The copper-free solution is discarded and the resulting waste of acid adds to the cost of production. WILLIAM E. GREENAWALT, of Denver, Col., has designed an apparatus whereby sulphur dioxide is used as a depolarizer and reducing agent for ferric salts in the electrolysis of impure copper solutions containing iron. The application of sulphur dioxide to an electrolyte so that it will function effectively in reducing ferric salts produced by electrolysis and act as a depolarizer presents some difficulties. These are slight solubility of sulphur dioxide in water or copper solutions, particularly in hot solutions; its reducing action in cold solutions is slow but is effective in hot solutions. The slight solubility renders the effect transient. In the apparatus designed by Greenawalt a large volume of electrolyte contained in a closed tank is treated with sulphur dioxide by spraying the solution into sulphur dioxide gas by means of rapidly rotating disks, which also agitate the solution. A portion of the reduced solution is sprayed into a trough on the side of the closed tank from which it flows to the electrolytic cell. The rate of flow is such that the tailing solution from the cell contains less than 0.25 per cent ferric iron. The concentration of sulphur dioxide gas in the closed tank is maintained by a pyrites, sulphide concentrate or other burner. The gas passes in series through several reducing tanks and finally to a scrubbing tower which is fed with fresh solution from the leaching tanks. The solution from the tower flows to the first reducing tank. In the arrangement described there are two electrolytic cells for each reducing tank, a portion of the oxidized solution from the first pair of electrolytic cells is bypassed to the second reducing tank and so on. (1,353,995; Sept. 28, 1920.)

**Alloys.**—The following special alloys are described by FOSTER MILLIKEN of Lawrence, N. Y.:

An alloy to resist high temperatures and the action of acids, alkalis and chemical mixtures at high temperatures:

	Per Cent
Copper .....	50 to 60
Nickel .....	28 to 36
Zinc .....	4 to 8
Iron .....	4 to 8

An alloy designed for the manufacture of valves and fittings, particularly those used in handling gasoline and light petroleum distillates:

	Per Cent
Lead .....	10 to 14
Copper .....	55 to 65
Nickel .....	6 to 11
Zinc .....	14 to 18

Acid-resistant and high-temperature-resistant alloy:

	Per Cent
Iron .....	16 to 20
Chromium .....	5 to 7
Copper .....	31 to 38
Nickel .....	38 to 46
Manganese .....	1 to 2

(1,354,988; 1,354,989; 1,354,990; assigned to Foster Milliken, S. Fullerton Weaver and James M. Repplier, as trustees; Oct. 5, 1920.)



### British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

**Preparation of Phthalic Anhydride.**—Phthalic anhydride is prepared by passing naphthalene vapor mixed with oxygen-containing gas—e.g., air—over an appropriate catalyst at a temperature below red heat, say 380 to 400 deg. C.; suitable catalysts are vanadium or molybdenum oxides. The catalyst may be prepared, for example, by impregnating pumice with a colloidal solution of vanadic acid mixed with starch or finely-divided blood charcoal, drying, and heating in air to burn off the carbonaceous matter; or by soaking pumice in gum solution, and then shaking it with ammonium vanadate; or powdered pumice is mixed with ammonium vanadate and suitably formed; or ammonium molybdate is precipitated on pumice by means of blood charcoal, and the charcoal then burnt off by heating in air. (Br. Pat. 145,071—1919. A. WOHL, Langfuhr, Danzig, Aug. 18, 1920.)

**Hardening Metals.**—The hardness and tenacity of metals, particularly aluminum and its alloys, and their ease of working with cutting tools are increased by heating for a considerable length of time to a temperature below the usual annealing temperature. An aluminum-zinc alloy with 15 per cent of zinc after being cast or annealed at 530 to 550 deg. C. is kept at 70 deg. C. for four or five days; an aluminum-copper alloy with 2 per cent of copper is kept at 160 deg. C. for ten days. Bronze with 6 per cent of tin is kept at 500 deg. C. for five days, and brass with 28 per cent of zinc is kept at 300 deg. for three days, or 210 deg. C. for ten days. Soft iron is kept at 300 deg. C. for fifty days. The heating may be interrupted during the process to enable the metal to be shaped, whereupon the heating is continued until the final hardness is attained. (Br. Pat. 145,129—1919. SOC. ANON. DES USINES GIULINI, Basel, Switzerland, Aug. 25, 1920.)

**Printing Fabrics and Yarns.**—Discharge effects are obtained by first mordanting cotton fabrics or yarns with tannate of aluminum, iron or chromium, then printing on a thickened solution of caustic alkali, to which may be added vat or sulphur dyes and a reducing agent, or an alkaline mordant such as sodium aluminate or an alkaline lead solution, or both, then aging or steaming, washing or otherwise preparing for dyeing, and finally dyeing with colors appropriate to the mordants used. The initial mordanting may be effected by first applying aluminum, iron or chromium mordants and then dyeing, padding or printing with tannin, or vice versa, or the metal salt and tannin may be applied simultaneously. Other colors—e.g., aniline black, vat or sulphur dyes—or diazo compounds (on fabric prepared with  $\beta$ -naphthol), or other discharges may be applied at the same time. Glucose, glycerine or tannin may be added to the alkaline discharges. According to examples—fabric is chrome-mordanted, tanned, printed with the alkaline discharge, aged, washed and dyed; fabric is padded with a solution of tannin and potassium chlorate, padded with iron acetate, printed with the alkaline discharge, aged, washed and dyed; fabric is printed with a mixture containing iron acetate, tannin, acetic acid, hydrosulphite N F conc. and starch-dragon thickening, aged, washed and soaped, printed with the alkaline discharge, aged, washed and dyed; fabric is padded with a solution of tannin and potassium chlorate,

printed with iron acetate and aluminum acetate simultaneously, aged, washed and soaped, printed with the alkaline discharge, aged, washed and dyed. (Br. Pat. 145,240—1919. CALICO PRINTERS' ASSOCIATION, Manchester; W. ROUSE, Renfrew and G. NELSON, Hyde, Cheshire, Aug. 25, 1920.)

**Scouring Wool.**—Raw wool, woollen yarns and cloth, and mixed goods are scoured, etc., by treatment with the alkaline salts of acids of the type of lysalbinic and protalbinic acid, to which cleaning material such as ammonia salts, sodium carbonate, potassium carbonate and soap may be added. The wool, etc., may be scoured at a temperature of 70 deg. C. The first-mentioned alkaline salts are prepared by heating albuminoid matter in alkaline solution—for example by heating glue in a solution of caustic alkali to 80 or 85 deg. C. for from two to three hours—neutralizing the solution with weak formic acid, and then concentrating the solution. Impurities may be removed by treating with dry calcium or magnesium hydroxide, or both, filtering, and then adding sodium carbonate. (Br. Pat. 145,448—1919. C. BENNERS, Grunau, near Berlin, Aug. 25, 1920.)

**Sulphuretted Dyes.**—Sulphuretted dyes are obtained by heating with sulphurizing agents mixtures of aminoazo, diaminoazo, nitroaminoazo, nitrooxyazo, or aminoxyazo compounds with C-alkylated diamines of the benzene or naphthalene series, for example *m*- or *p*-toluylenediamine or xylylenediamine, or N-aryl-derivatives of such diamines, for example naphthyl-*m*-toluylenediamine, or the corresponding nitroamines. According to examples products are obtained by heating with sulphur mixtures of *m*-toluylenediamine with aminoazobenzene, benzene-azo- $\beta$ -naphthylamine, benzene-azo- $\alpha$ -naphthylamine, *p*-nitrobenzene-azo- $\alpha$ -naphthylamine, or *p*-nitrobenzene-azo- $\beta$ -naphthylamine, and a mixture of 4- $\alpha$ -naphthylamino-2-aminotoluene with benzene-azo- $\alpha$ -naphthylamine. The products are solubilized by treatment with sodium sulphide and dye cotton olive, reddish-brown, brown, yellow-olive, yellowish-brown, and brown to black brown shades. Products are also specified from mixtures of *m*-toluylenediamine with *p*-nitrobenzene-azo-*m*-toluylenediamine (brownish orange), benzene-azo-*m*-phenylenediamine (black brown), *p*-nitrobenzene-azo-cresol (crude cresol mixture), a benzene-azo-phenol, or a benzene-azo-naphthol. (Br. Pat. 145,523—1920. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

**Cellulose Acetate.**—Cellulose acetate soluble in acetone is dissolved in a fully hydrogenized monocyclic ketone such as cyclohexanone or methylcyclohexanone, to form solutions suitable for lacquering and for the production of artificial silk and films. A solvent or diluent, as for example, alcohol, acetone, ethyl acetate or benzene, may be added to the ketone. (Br. Pat. 145,511—1919. BADISCHE ANILIN UND SODA-FABRIK, Ludwigshafen-on-Rhine, Sept. 1, 1920.)

**Sulphuretted Dyes.**—Sulphuretted dyes are obtained by heating with a sulphurizing agent the azo compounds prepared by coupling diazo compounds with N-ethylarylamines; aromatic amines or substances yielding them such as nitroamino or azo compounds may be added to the melt. According to examples products are obtained by heating with sulphur *p*-nitrobenzene-azo-ethyl- $\alpha$ -naphthylamine, *p*-aminobenzene-azo-ethyl- $\beta$ -naphthylamine, *p*-aminobenzene-azo-ethyl- $\beta$ -naphthylamine, a mixture of benzene-azo-ethyl- $\alpha$ -naphthylamine and ben-

zidine, a mixture of benzene-azo-ethyl- $\alpha$ -naphthylamine, and benzene-azo- $\alpha$ -naphthylamine, or a mixture of *p*-nitrobenzene-azo-ethyl- $\alpha$ -naphthylamine and *m*-toluylenediamine. The products are solubilized by treatment with sodium sulphide, and dye cotton yellow-brown and brown-yellow shades. (Br. Pat. 145,522—1919. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

**Edible Gelatine.**—Edible gelatine is prepared in sheet form by applying a coating of liquid gelatine to a flexible foundation from which when dry the coating is stripped as a sheet, and finally, in order to simulate the crinkled appearance of ordinary edible gelatine, placing the sheets in a frame of wire netting, softening by momentary immersion in hot water, and redrying while in the frame, for example, in the current of air from a blower. (Br. Pat. 145,486—1919. R. A. MCQUITTY, London, Sept. 1, 1920.)

**Treating Cellulose and Its Products.**—Pure cellulose such as cotton, cellular tissue and papers and cardboard made therefrom are hardened and rendered water-resisting by treatment with thionyl chloride. Indifferent solvents for the thionyl chloride, such as chloroform, carbon tetrachloride, benzene, etc., may be used. A better parchmenting effect on paper is produced by exposing the paper, after treatment if necessary in vacuum, to the vapors of thionyl chloride. Continued treatment renders paper absolutely impermeable. It is desirable, after treatment, to wash with water or dilute alkali, or to treat with dry ammonia gas. (Br. Pat. 145,610—1919. F. MOELLER, Cassel, Germany, Sept. 1, 1920.)

**Treating Cellulose and Its Products.**—The process described in Br. Pat. 145,610—1919 may be applied to the treatment of vegetable materials containing cellulose, such as wood, cork, straw, jute, hemp, linen, flax, artificial silk, yarns and fabrics obtained therefrom, cellulose derivatives such as cellulose hydrate, hydro-cellulose, oxy-cellulose, kindred substances such as starch, dextrine, or fabrics and substances treated or impregnated therewith. These materials may also be hardened and rendered less sensitive to water by treatment with sulphur chloride, the deposited sulphur being subsequently removed by a suitable sulphur solvent. The products of this treatment may be parchmented and the fat-resisting material so obtained rendered water-repellant by further treatment with thionyl chloride. (Br. Pat. 145,611—1919. F. MOELLER, Cassel, Germany, Sept. 1, 1920.)

**Coated Fabrics.**—In the production of coated fabric for balloons, etc., the elasticity and softness of the fabric are retained by impregnating with a pliable medium, such as castor oil or a solution comprising softening agents, previous to the application of the coating of nitrocellulose, etc., thereby limiting the penetration of the coating material into the fiber of the fabric. (Br. Pat. 145,546—1919. GES. FÜR VERWELTUNG CHEMISCHER PRODUKTE, Berlin, Sept. 1, 1920.)

**Cellulose Acetates.**—The acetylation of cellulose or its derivatives is carried out in two stages: In the first stage a catalyst other than sulphuric acid is employed, or several of such catalysts either simultaneously or in succession, and in the final stage sulphuric acid is used as the catalyst. Working in this way, complete solution of the cellulose is obtained, and the acetates can be separated from the solutions by dilu-

tion with or in the presence of acetone; the solubility of the acetates may be varied by subjecting them in the known way to a process of hydrolysis. In examples, bromine and fused zinc chloride are used as catalysts in the first stage, and acetylation is completed after the addition of sulphuric acid diluted or not with glacial acetic acid and with or without a further addition of acetic anhydride. (Br. Pat. 145,525—1919. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

**Compound Sheet Materials.**—A method of uniting two or more layers of dissimilar materials, particularly plastic materials, which are difficult to stick together—for example, uniting rubber with other plastic materials—consists in providing a suitable intermediate layer to which the layers to be connected firmly adhere. Materials suitable for the intermediate layer are pulverulent materials such as straw meal, wood meal, barium sulphate, talc, china clay, vegetable powders, etc., or fibrous materials such as textile fibers, cellulose fibers, wadding, fiber fleece, etc., or a layer of paper or wide-meshed fabric. For example, a gas-proof and liquid-tight fabric may be prepared by coating a fabric foundation with acetyl-cellulose as a gas-proof layer, then applying the intermediate layer before acetyl-cellulose is completely dry; and finally applying a liquid-tight layer of nitrocellulose. (Br. Pat. 145,544—1919. GES. FÜR VERWELTUNG CHEMISCHER PRODUKTE, Berlin, Sept. 1, 1920.)

**Degumming Textile Materials.**—In an amylolytic process for degumming textile materials, such as fabrics, a bath which may be prepared from ordinary hard water is employed containing animal amylase, neutral salts of alkali or alkaline-earth metals such as sodium or calcium chloride, and biliary salts, whereby the amylase is protected, and the bath may be used at a temperature of 58 deg. C. (Br. Pat. 145,583—1919. SOC. SUISSE DE FERMENTS, Basel, Switzerland, Sept. 1, 1920.)

**Oxyaldehydes.**—Oxyaldehydes are prepared by the reaction of phenols or their derivatives with formaldehyde, or a compound yielding it, in the presence of a nitroso compound and an acid condensing-agent. Examples are given of the preparation of salicylic aldehyde and *p*-oxybenzaldehyde, 2-oxy-5-methylbenzaldehyde, anisic aldehyde, vanilin, protocatechuic aldehyde, and the aldehyde from 2-naphthol-3:4-disulphonic acid; the nitroso compounds specified are nitrosodimethylaniline, nitrosodiethylaniline, and nitrosophenol, hydrochloric acid being employed as condensing-agent. (Br. Pat. 145,581—1919. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

**Damp-Proof Matches.**—A process for making damp-proof matches consists in using in the paste from which the heads are formed an agglutinating substance formed by the condensation product of a mixture of substances having the properties of phenol and of an aldehyde. These substances react when heated and produce, in the presence of suitable catalyzers, insoluble bodies. For example, a paste is prepared by placing the powdered constituents in a bath containing water, phenol aldehyde and soda, the stalks are dipped into this bath and after removal the tips are allowed to harden. The aldehyde and the catalyzer, which may be hydrochloric acid, may be used in the form of vapor. (Br. Pat. 145,798—1919. R. DUBRISAY, Paris, Sept. 1, 1920.)



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## Current Events

### in the Chemical and Metallurgical Industries

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#### The Perfume Industry of France

On Friday evening, Nov. 12, Burton T. Bush, president of Antoine Chiris Co., addressed the American Section of La Société de Chimie Industrielle on the natural perfume industry of France. Excellent views of the flower fields near Grasse and interiors of the attar extraction factories were exhibited on the screen. Three processes of extraction were illustrated:

Enfleurage, or the cold fat process, is the oldest. The blossoms are packed in layers with soft tallow cloths between, the attar vapors being adsorbed, giving the odorous pomas from which the cologne spirit perfumes are prepared.

Maceration, or the hot fat process, is used where heat does not injure the essential oils. The blossoms are ground up and cooked in molten fats heated by hot water and pomas made much more rapidly than in the cold process.

Countercurrent extraction with pure petroleum ether is the latest method, giving a high rate of production and low-temperature extraction. Concretes, a solution of the attars in the natural blossom waxes, are produced.

Only about 11 oz. of substance is obtained from 100 lb. of such a flower as lavender. Last year 121,000 lb. of violets, 1,200,000 lb. of roses and 500,000 lb. of bitter orange blossoms were extracted. The demand for cosmetic odors cannot be supplied by the natural industry, with the result that synthetic products are now being produced in great quantities. In the United States, 36,000 lb. of ionone (synthetic irone or extract of violet) was manufactured last year. Mr. Bush expressed the opinion that if this industry is given tariff protection, it will grow greatly.

#### Annual Meeting of American Ceramic Society

The 1921 annual meeting of the American Ceramic Society will be held Feb. 21 to 24, at Columbus, Ohio, where the Hotel Deshler has been engaged as headquarters. The management of this new and commodious hotel has promised to reserve the ball-room and four other rooms on the same floor, so that the general meetings of the society and the divisional meetings will be taken care of adequately.

Details of the entertainment are in the hands of the local committee, of which Prof. A. S. Watts is chairman, and it is expected that the usual Section Q, or smoker, will take place on Monday night, with the banquet on Tuesday. Those who recall these delightful events at the Philadelphia meeting will not fail to be present this year.

The trips to be taken on the last day of the meeting will be replete with interest, as Columbus is situated at the very heart of the clay-working industry.

The literary program, if it may be judged by past experience, will be filled with papers of a high degree of excellence. The arrangement of the program is in charge of R. H. Minton, chairman of the Committee on Papers, and contributors should communicate with him.

#### New Jersey Chemical Society Holds Third Annual Meeting

The third annual meeting of the New Jersey Chemical Society was held at Newark Monday evening, Nov. 8. Thirty-three new members were elected at this meeting, thereby making a total membership for the society of 516.

Richard K. Meade<sup>1</sup> gave an illustrated talk on the manufacture of lime and hydrated lime, emphasizing the different types of furnaces used, the various methods of firing, and the products produced.

James A. Donan, a representative of the Standard Oil Co. of New Jersey, accompanied the moving pictures depicting "The Story of Petroleum Oil," by an address in which he explained and elaborated on the pictures, describing the production of oil and its byproducts from the oil well to the consumer.

E. E. Klipstein, who was to talk on "Prospective Competition Between European and American Chemical Industries," was unable to be present, and his place was taken by Dr. R. S. Lee, who gave an extremely interesting illustrated lecture on the yeast industry.<sup>2</sup>

#### National Council of State Boards of Engineering Examiners Formed

Representatives from seven state boards of engineering examiners—Colorado, Michigan, Iowa, Florida, South Dakota, Louisiana and Illinois—met in Chicago Nov. 8 and 9 and organized the National Council of State Boards of Engineering Examiners.

The purpose stated in the constitution as "to examine the state laws providing for registration of engineers and the custom and rule of procedure of the different boards in the examination of applicants, with suggestions and recommendations for uniformity of practice so far as the same can legally be done by the different state boards, and to provide for reciprocal relations between the state boards for granting registration licenses to applicants from other states on equal terms of examination."

The officers elected were: President, Marcel Garaad, New Orleans; vice-president, C. S. Hammatt, Jacksonville, Fla., and secretary-treasurer, Alvin Le Van, Des Moines, Iowa. The next meeting will be in St. Louis, Oct. 3, 1921.

#### Bureau of Mines Station at Rolla, Mo.

Bureau of Mines representatives are touring the Wisconsin zinc district and the Missouri lead and zinc districts investigating various conditions connected with the location of the new Mississippi Valley zinc and lead station at Rolla, Mo. Among other members of the party were Frederick G. Cottrell, director of the Bureau; Charles Fulton, president Missouri School of Mines, and H. A. Buehler, State Geologist of Missouri.

<sup>1</sup>See CHEM. & MET. ENG., "The Manufacturing of Lime for Chemical and Metallurgical Purposes," vol. 23, Nos. 17, 18, 19, pp. 841, 873 and 929.

<sup>2</sup>See CHEM. & MET. ENG., vol. 23, No. 17, pp. 835-837.



### American Coke & Chemical Co. Begins Operating the St. Louis Plant

The St. Louis Coke & Chemical Co., subsidiary of the American Coke & Chemical Co., has heated the first forty ovens and blast furnace and will start the second bank of forty ovens within the next six weeks. By Dec. 1 the plant will produce from 100 per cent Illinois coal metallurgical coke for the blast furnaces, tar, gas for the steel mills of the National Enamelling & Stamping Co., ammonium sulphate, light oils and pig iron. The conversion of Illinois coal is made possible by the Roberts coke oven, invented by Arthur Roberts, an American.

The American Coke & Chemical Co., of 208 South La Salle St., Chicago, controls subsidiary companies in several states, all licensed under the Roberts patents. Work will be started in Chicago this winter on the first unit of 320 ovens, the plant to be laid out for the eventual construction of 1,500 ovens. Plants of 80 ovens will be started in several other places in the early spring.

The Roberts process is said to be the first successful method for the coking of coals such as are mined in Illinois. The original test was run in the 24-oven plant at Dover, Ohio, where 16,000 tons was put through. The coke was used to produce pig iron at the plant of M. A. Hanna & Co. and the pig was reduced to steel plates at the Niedringhaus plant, Granite City, Ill. These plates after passing all Government tests were shipped to the Pacific Coast, where they were used in the construction of Hull No. 18 of the United States fleet.

The inventor states that the reasons for the excellent performance of this oven, as compared with other processes attempting to coke soft coals, is due to the absolute control of the heat. The heat is generated uniformly on all surfaces and not at concentrated points. The distribution of heat is even and in large volume as distinguished from high temperatures existing in other ovens. Short coking time and low temperature are accomplished by special construction which permits the large volume of heat in contrast to high temperatures now obtaining in narrow coking chambers. For these reasons superiority is also claimed in converting the regular coking coals.

Representatives of foreign business concerns are interested in this new American process. Japan can now coke only about one-half of 1 per cent of the coal mined; the Saar Basin and Lorraine coals have never been coked; only 10 per cent of the British coals are convertible and only 5 per cent of the United States coals are at present cokable. South America, Russia and other countries may be likewise benefited by the new process.

### A.C.S. Intersectional Meeting

The Milwaukee and Chicago sections of the American Chemical Society will meet in joint session at Milwaukee on Nov. 20. Among the features of the occasion will be an indoor baseball game between teams of the two sections. The meeting originated on invitation from the Milwaukee Section. The social interchange between Western groups in the American Chemical Society promises to become contagious, causing a closer welding of all the parts into a better national organization.

### St. Lawrence Waterway Hearings Under Way

The series of hearings before the International Joint Commission, which will be held in all the principal cities affected by the Great Lakes-St. Lawrence waterway project, was initiated in Chicago recently. Evidence was presented to show that:

1. The interior of the country—richest in productivity—is to a large extent the present and will be the future origin of America's export shipments.

2. This same section, by reason of its growing population, is to a large extent today and will be to a greater extent tomorrow the market for America's imports.

3. The need of more adequate means of ingress and egress from the central section of the United States and Canada to the markets of the world is America's greatest economic problem.

4. Increasing cost and difficulties of rail transportation from Atlantic seaports are placing a burden on commerce that is becoming prohibitive.

5. This waterway improvement comprising the completion of a route up the St. Lawrence from Quebec through Lake Ontario, the Welland Canal, Lake Erie and via Detroit to the whole system of the Great Lakes, costing about \$110,000,000, will provide the necessary facilities.

The Canadian section of the work will cost about \$60,000,000 and the international section about \$50,000,000. It is estimated that about 4,000,000 electrical horsepower would be developed in the system.

### Compression and Hardness of White Metal Bearing Alloys

Experimental work on determining the compression and hardness value of white metal bearing alloys at temperatures up to 100 deg. C. has been completed by the United States Bureau of Standards. A paper has been prepared entitled, "Some Properties of White Metal Bearing Alloys at Elevated Temperatures," a summary of which is as follows:

An apparatus is described for determining the yield point and ultimate strength of white metal bearing alloys at temperatures up to 100 deg. C. A new design of heating apparatus is described for determining the Brinell hardness of such metals in the range of temperature indicated above. The results of compression tests and Brinell hardness tests at temperatures up to 100 deg. C. are given for five typical white metal bearing alloys, including three tin base alloys, one lead base alloy and one intermediate alloy. These tests showed that the tin base alloys maintain their properties better at elevated temperatures than those containing lead. Results of tests are given which indicate that up to 3 per cent the lead in a high-grade babbitt does not affect the yield point or ultimate strength at 25 deg. C. or 75 deg. C. Tests are described which show that the yield point of tin base alloy is not affected by heating for six weeks at about 100 deg. C., but that the yield point is lowered in the lead base alloy by heating for only two weeks at this temperature.

### Strong Paper Co. Changes Name

The Strong Paper Co. of Middletown, Conn., has changed its name to the Elam Strong Paper Co., and has increased its capital stock from \$100,000 to \$160,000.

### New Forestry Policy Sought by the A.P.P.A.

A new forestry policy was recommended in the reports read at the American Pulp and Paper Association, which recently met in Chicago. It is said that the Federal Government is preparing to spend \$50,000,000 on forestry in the next five years in addition to large amounts to be expended by individual states.

The reports urge acquisition by State and Federal Governments of forest land and land for reforestation. Extension of federal supervision of state and private forests and a unified system of reforestation under federal control are also advocated.

To stop the cutting of young timber to pay taxes it was proposed that no state or federal taxes be collected on forest land until cutting of the timber started and that the tax then be placed on the lumber.

President George W. Sisson of the association said the paper industry is "in a better situation than many others because it had not been through a period of overproduction which piled up excessive stocks."

"On the contrary," he continued, "the mills have been barely able to keep up with the flood of orders. Our great problem is now and will continue to be the securing of a sufficient supply of raw material to meet the needs of the mill."

### Fermogas Promoter Held for Grand Jury

Legal action has been brought against P. J. Chasler of 1259 51st St., Brooklyn, N. Y., for the alleged misappropriation of funds given him for investment in the Fermogas Co. This company has a small demonstration plant in which the Chasler process of fermenting cellulose to alcohol by means of a mold is shown to prospective stock purchasers. The claim is made that gasoline substitute can be produced and sold at a profit at 5c. a gal. The process has been examined by many investors and about \$70,000 worth of stock has been sold. However, there does not appear to be any technical proofs or recognized alcohol engineers' reports available to verify the claims of the inventor. The complaint was filed by Emmerick Bares, who bought \$5,000 worth of stock. Mr. Chasler was held under \$10,000 bail to await action of the Grand Jury.

### E. A. Cappelen Smith Recipient of Gold Medal

At the meeting of the Mining and Metallurgical Society held at the Hotel Commodore, New York City, E. A. Cappelen Smith was awarded the society's gold medal for his excellent work in hydrometallurgy. Mr. Smith, who originally came to this country from Norway as a metallurgist, followed his profession here with the Anaconda Copper Co. and later with the Chile Copper Co. It was while connected with the latter company that he carried successfully to solution the problem of reclaiming copper from the great Chiquicamata orebody in Chile by leaching and subsequent electrolytic deposition of copper.

The medal was presented by Waldeman Lindgren, president of the society, and speeches were made by Dr. Arthur L. Walker and Harry F. Guggenheim.

### Shortage of Crude Oil Closes Plant

The Imperial Oil Co. has had to close its refinery at Ioco, near Vancouver, because it is unable to obtain crude oil, and consequently cannot renew contracts for fuel oil. The refinery will be reopened in June.

### No Quarters for Civilian Chemists at Edgewood Arsenal

The War Department has ruled definitely that no quarters for civilian chemists may be erected at Edgewood Arsenal with War Department funds. The decision was based on the ground that the War Department could not depart from its policy of furnishing quarters to officers only. It is feared that this decision will have the effect of decreasing efficiency at Edgewood Arsenal, since its isolated location makes it necessary for the technical employees to live in Baltimore, which is forty minutes away. The train schedule is such that men who would be inclined to work overtime cannot do so.

### Enlarging Iron Articles

In *CHEMICAL & METALLURGICAL ENGINEERING* for Sept. 1, 1920, a brief abstract of a paper read before the British Institution of Automobile Engineers was printed. It noted that it was commercially possible to deposit electrolytic iron on worn parts of machinery, to build them up to approximate size so that they can be carburized and machined to a piece practically as good as new. It should have been pointed out that the process was originated in Sherard Cowper-Coles' laboratory at Sunbury-on-Thames, and was largely used for the repair of worn parts of motor cars during the war.

## Book Reviews

ADVERTISING THE TECHNICAL PRODUCT. By *Clifford Alexander Sloan*, vice-president Campbell-Ewald Co., and *James David Mooney*, vice-president's staff General Motors Corporation. 365 pp., with illustrations and charts. New York: McGraw-Hill Book Co., Inc. Price \$5.

Prepared jointly by an engineer and advertising man collaborating with several authorities in both fields, this work is valuable for study and reference to the buyer and seller of advertising space alike, as well as to those who have technical products for sale and must plan selling campaigns. It is a clear analysis of the important factors peculiar to advertising the technical product. Many an advertiser can save considerable money now being wasted through lack of attention to the forces governing his selling plan. The salesman of space, on the other hand, will see in reading the text and between the lines that he must study to present the facts bearing on the economic returns to the advertiser and should not rely on the too common form of "good fellow" salesmanship. The principles laid down in this book may well be applied to general advertising procedure.

The authors have done well in dealing with cold facts and principles in contrast to the "pep" talk so commonly found in volumes on advertising and selling. The style and text matter in the first chapters make for interesting reading, the final chapters and appendix being largely a collection of data evidently gathered from reliable sources. It is a book for continued reference. Even those who feel they have graduated from the school of study may crystallize ideas and derive inspiration for fresh thought in its use.

Some parts of the text drag slightly, but the amount of superfluous matter is surprisingly small. The authors strike a false note once or twice in apologizing for reference to certain publishers of trade papers and journals. The open-minded reader would not take issue over these references or feel any stigma attached to sources of data, and the opinion of the superficial, suspicious reader doesn't matter.

CHESTER H. JONES.



## Personal

DR. WILDER D. BANCROFT, professor of chemistry at Cornell University, delivered an address before the Chicago Section of the American Chemical Society on "Contact Catalysis" on Nov. 6. The Chicago Chemists' Club gave a special luncheon for Dr. Bancroft at noon the same day. Dr. Bancroft also spoke before the students at Chicago University and Northwestern University the following week on "Colloids" and "Drops, Bubbles and Grains."

Captain D. B. BRADNER, acting director of research at Edgewood Arsenal, has resigned his commission and will continue his duties as a civilian.

ARTHUR HOWE CARPENTER has accepted the position of assistant professor of metallurgy at the Armour Institute of Technology, Chicago, Ill.

RICHARD H. CATLETT has resigned as production manager of the Taylor Chemical Co., Penn Yan, N. Y., to be chemical engineer with the Lewis Recovery Corp., Boston, Mass.

SIDNEY CORNELL will be engaged in professional work in Philadelphia for some time to come and can be addressed at 28 Cliveden Ave., Glenside, Pa. Mr. Cornell still retains his New York office at 80 Maiden Lane.

W. A. DEAN has resigned from the technical staff of the Dorr Co., New York, and has accepted a position as manager of the Gulf Reduction Co. His post office address will be Camp Walton, Fla.

SHERMAN EATON, who was formerly with the Wharton Steel Co., Wharton, N. J., is now with the Continental Clay Co., Langley, S. C.

Colonel C. W. EXTON has been transferred from the Infantry to head the training section of the Chemical Warfare Service. Colonel Exton, in addition to having been graduated from West Point, has been through the service schools of Fort Leavenworth and recently was graduated from the General Staff College. During the war he was Commandant at the service schools in France, in which emergency Chemical Warfare officers were among those trained.

ALBERT H. FAY is now valuation engineer, Oil and Gas Section, Internal Revenue Bureau, Washington, D. C.

LOUIS J. GUREVICH, research metallurgist, research department, Hydraulic Steel Co., Cleveland, Ohio, has been transferred in like capacity to the Canton Sheet Steel plant of the same company at Canton, Ohio.

A. L. HEILBRUNN of the Fleischmann Yeast Co., Chicago, spoke before the Chicago Chemists' Club recently on "Industrial Fermentation."

RAYMOND M. HOWE, of the Mellon Institute, spoke at the regular monthly meeting of the Pittsburgh Foundrymen's Association at the Hotel Chatham, Pittsburgh, Nov. 15. Mr. Howe spoke on refractories, with special reference to their application in foundry practice.

WALTER LAIB, who has been with the Ohio Salt Co., Rittman, Ohio, for nine and a half years as chief chemist and general superintendent, has resigned to assume the position of treasurer and sales manager of the Cleveland Match Co.

ROBERT J. MCKAY, superintendent of the research department of the International Nickel Co., of Bayonne, N. J., is now industrial fellow at the Mellon Institute, Pittsburgh, Pa.

Miss JESSIE E. MINOR, who has been for several years the chief chemist for the Hammersley Manufacturing Co. of Garfield, N. J., has recently moved to Springfield, Mass., to take charge of the pulp and paper department of the Emerson Laboratory at 145 Chestnut St. Miss Minor was for several years a graduate student at the University of Pennsylvania and later studied at Bryn Mawr, where she received the degree of Doctor of Philosophy in chemistry. She also spent several years studying industrial conditions in the Union of South Africa.

HARRY S. MULLIKEN has been engaged by the Bureau of Mines to act as special technical assistant to Director F. G. Cottrell. Mr. Mulliken's appointment puts into effect a plan which has long been considered of having a technical engineer attached directly to the office of the director. Mr. Mulliken is a graduate of the Worcester Polytechnic Institute. He began industrial metallurgical work with the Chicago and Aurora Smelting & Refining Co. He has since served as superintendent of the Pilot Bay, B. C., lead smelter; assistant superintendent of Gregg Refineries at Perth Amboy, N. J.; superintendent of the Aguascalientes Smelter of the American Smelting & Refining Co.; general superintendent of the Peñoles Co., at Mapami; superintendent of the American Metals Co., in Mexico. During recent years Mr. Mulliken has been practicing as a consulting engineer, with offices in New York.

BERT RUSSELL, who left the Patent Office a little over a year ago after extended service in its various chemical divisions, will, on Dec. 1, 1920, leave the service of Prindle, Wright & Small, New York City, to accept employment in the office of Roy F. Steward, chemist and patent attorney, McLachlan Bldg., Washington, D. C.

H. A. SCHWARTZ has become manager of research for the National Malleable Castings Co., Cleveland, Ohio.

LEWIS B. SKINNER, chemical and metallurgical engineer, of Denver, Col., is now connected with the Midwest Refining Co.

E. A. CAPPELEN SMITH has been awarded the gold medal of the Mining and Metallurgical Society of America for distinguished contributions to hydrometallurgy.

ARTHUR H. SPURLOCK, formerly of the American Refractories Co., has become treasurer, in charge of finances, accounting, credit, collections, etc., of the H. H. Robertson Co., Pittsburgh, Pa.

Dr. WILLIAM H. WALKER, after twenty-five years of active service in teaching and research in applied chemistry and chemical engineering at the Massachusetts Institute of Technology, has tendered his resignation as director of the division of industrial co-operation and research, to take effect on Jan. 1, 1921. He will resume his consulting practice which was interrupted in 1917 by his entering the service, and although no longer officially connected with the institute, will maintain his interest in the development of the division and will closely co-operate with it in the fulfillment of the contracts under the Technology Plan already existing. This division acts for the Institute of Technology in the administration of its obligation incurred under the Technology Plan by which over 200 of the most prominent industries of the country have made contracts involving annual retainer fees of over a quarter million dollars. Dr. Walker will be succeeded by Prof. Charles L. Norton, professor of industrial physics at the institute and director of the Research Laboratory of Industrial Physics.

## Current Market Reports

### The Chemical and Allied Industrial Markets

New York, Nov. 15, 1920.

Consumers have not lent active support to the chemical market during the week. Some trace of an irregular buying movement was inaugurated, but the punch has been lacking and operations were not impressive. There are many different opinions as to when a resumption of live trading will be noticed and even the best informed find it quite impossible to make any definite prediction, since no parallel situation has ever been witnessed before in the chemical market. Export orders reached the market in moderate quantities, principally for heavy chemicals to Europe. *Formaldehyde* prices were greatly depressed by large resale offerings and the market drifted into new low territory. Final quotations ranged from 24c. to 25c. per



lb. Small lots of *borax* are being moved at 9½@10c. per lb., according to time of delivery and quantity. Sales of brown, broken *acetate of lead* are reported by producers at 15½c. per lb., while white crystals are moving at 15@15½c. per lb. The inquiry is reported fairly active and supplies show no signs of accumulation in any direction. Dealers offer carlots of powdered *sodium bisulphite* at 6½c. per lb. and 7c. in smaller quantities. This chemical has been in rather limited supply of late, but seems to be getting in better shape for prompt delivery. *Nickel salts* has been a surprise to local consumers, who expected a decline. Leading producers have not altered former quotations and are holding the single variety at 16c. per lb., and the double at 14c. per lb. *Barium chloride* has been reduced by leading holders, owing to the large supplies that were recently imported from Europe. Ton lots have changed hands as low as \$85 per ton. This seemed to be an inside figure and the general quotations heard range from \$90 to \$95 per ton.

#### COAL-TAR PRODUCTS

Buying of a very conservative order is still in evidence in practically all branches of the coal-tar market, with orders directed entirely to the present consumption. In producing quarters most factors realize the quiet conditions, but find sufficient business to keep plants in fair operation. Bituminous coal supplies and prices are reported quite favorable and tend to a steady production of crude by-products. *Aniline oil* retains its easy tendency, with the demand very light and supplies available in first hands at 27@30c. per lb. depending upon quantity. Leading factors in *benzaldehyde* report sales limited to small lots, with prices ranging for the technical grade at 65@70c. per lb. and U.S.P. at \$1@1.50 per lb. *Paratoluidine* remains quite firm in the hands of producers. The demand is sufficient enough to keep prices steady at \$1.85 per lb. *Xylene* is heard only in light routine demand and prices range from 45c. to 50c. per gal. *Napthalene* is meriting more interest among intermediate manufacturers and contract prices over next year are heard at 14c. per lb. Very little business is being turned at this figure and consumers are keenly looking forward to more normal prices.

#### SODIUM SALTS OVER 1920

The beginning of 1920 was the signal for a sharp impetus to all *sodium salts*. Reports from leading producers of an acute coal shortage brought *bichromate of soda* to the front with smashing advances ranging from 18c. per lb. in January to 45c. per lb. quoted in April, its brightest month. *Caustic soda* began its gradual climb during January and reached its peak in April. The incessant demand from all parts of the world, together with the abnormal railroad conditions, brought about a severe shortage on spot markets and domestic consumers were forced to pay a premium from second hands. *Soda ash* followed in sympathy with *caustic soda*. A novel feature of the market was the sensational rise of *nitrite of soda* from 14c. per lb. to 50c. per lb. Domestic manufacturers were hampered by a shortage of *soda ash*, one of the main constituents in its production, and importations were almost at a standstill. During March, 1920, a shipload of *nitrite* was ruined by an explosion and within forty-eight hours the price advanced from 15c. per lb. to 50c. per lb. All other *sodium salts* listed here have followed suit with the leaders due to the vast accumulation of export orders on the American market. Prices since June, however, have gradually been declining to a normal basis. Depreciation in foreign exchange, ample supply of coal, more stable conditions in railroad transportation and keener competition have brought prices back to a pre-war situation. Manufacturers are once more striving to place business directly with the domestic consumers at prices which are satisfactory to both parties. The past few months have seen a radical change in general business principles. Contracts on leading chemicals have been placed with consumers through first hands only. This step practically does away with the dealer who, through his unscrupulous speculation, has proved so disastrous to the chemical industry.

#### SODIUM SALTS

Article	Jan.—March	April—July	Aug.—Oct.
Acetate soda.....	7@8½c.	9@12½@11½c.	11½@8½c.
Soda ash, 100 lb.....	\$2.25@3.50	\$3.75@3.10	\$3@2.25
Bichromate soda.....	18@40c.	45@24c.	22@12c.
Caustic soda, 100 lb.....	\$4.50@6.50	\$7@36	\$5.50@4@4.35
Cyanide soda.....	25@30c.	30@40c.	60@40@28c.
Nitrite soda.....	14@50c.	50@17c.	15@8½c.
Prussiate soda.....	22@32c.	32@26c.	25@22c.
Sulphide soda.....	5@6½c.	7@10c.	10@7c.

#### NAVAL STORES

*Turpentine* during the week has been very quiet and prices are still falling, with \$1.20 per gal. the prevailing midweek quotation. It is generally assumed that owing to the recent dullness throughout the naval stores list supplies of *rosins* and *turpentine* have been accumulating and that a large surplus now exists in the Southern market. However, the present levels are so close to production cost as to make a curtailment of output necessary and an estimate places the material on hand equivalent to five months' consumption. *Rosins* are nominally in the same position, with offerings of \$12.75 for B-N and \$13@13.25 for W.G-W.W. grades being turned down by consumers.

#### MISCELLANEOUS MATERIALS

There is a comparatively firm undertone in the *shellac* market and routine business has not suffered any great depression. Demand has been sufficient to sustain the A.C. garnet grade around 90c. and orange superfine at \$1.05@1.10 per lb. *Blanc fixe* has fallen off under pressure of accumulating supplies and the pulp grade is available at 3@3½c., while the dry grade in considerable quantities can be purchased at 5@5½c. per lb. Buyers continue to pay 14@18c. per lb. for *casein*, depending upon source and quantity, and it is not expected that this price will be lowered.

#### The Chicago Market

Chicago, Ill., Nov. 11, 1920.

The outstanding feature of the trade is the fact that, while demand continues light and supply plentiful, there are practically no distressed lots in sight, indicating that the speculative element has largely been eradicated. Supplies of all lines are in the hands of producers or legitimate dealers, this indicating that any future price movements will be toward a stable base and not the result of manipulation.

In no line does there seem to be any buying beyond immediate requirements, and the prevailing slowness in all other lines is directly affecting many chemicals. This is particularly true of coal-tar products. The anilines not only are contending with a fall season of unprecedented slowness in the textile industry but are also facing imports from abroad of sufficient volume to affect stocks materially. Low grain quotations and livestock markets are keeping oils at a low level and naval stores, owing to the lack of construction work, have failed to show their customary November strength. Flaxseed receipts continue heavy at primary points, with linseed oil prices correspondingly weak.

#### HEAVY CHEMICALS

*Alcohol* leads in interest by reason of sharp reductions in *methyl* grade and in *denatured*, the former being priced now at \$1.90@1.95 per gal. for 95 per cent and the latter at 85c. for 96 per cent. *Ethyl* grade is held firm at \$5.60 per gal. for 190 proof. The reductions mentioned have not brought any noticeable stimulation about. *Formaldehyde* is heard of as offered at prices all the way from 22c. to 28c. per lb., with transactions few and of small volume. *Mercury* is another weak spot, being quoted at \$60 per flask and some being sold at a dollar or two less. A topheavy market points to a further drop.

Reports from the East of heavy receipts of *bleaching powder* have depressed an already weak market and none can be sold above 5½c. per lb. Holders of stock are reluctant to let go at this figure and a negligible amount of business is the result. *Soda ash* is also very weak, spot offers of \$2.05@2.15 per 100 lb. attracting few buyers. *Caustic*

soda is quoted at \$2.25@2.40 for immediate delivery and is in fair demand with the higher figure most closely reflecting present worth. *Soda cyanide*, off in demand and plentiful in supply, is offered at 28c., but 27c. could buy it. *Glycerine*, in spite of curtailed production, continues to encumber the market, with dynamite grade offered at 20c., including drums, and very little sold. It is freely stated that further reduction is looked for.

With the sole exception of *nitric*, acids show weakness in price and poor demand. *Nitric* is being taken up about as fast as offered, prevailing price being about 7c. per lb. for 36 deg. *Acetic acid*, 28 per cent, is nominally 3c. per lb. and 60 deg. *sulphuric* \$16 a ton, with trading so dull that quotations mean very little.

#### COAL-TAR PRODUCTS

A small amount of business is reported in crudes, principally in benzene, naphtha and toluene. Intermediates are so dull that quotations are purely nominal. *Aniline oil* is quoted at 30c. a lb., *aniline salt* at 38c. and all related products are similarly weak. *Toluene* has witnessed some real demand and has changed hands at 38c. per gal. *Benzene*, at 36c. per gal. is quite firm and *naphtha*, with plentiful supply, is held firm at 35c. The long continued lack of demand in this class of goods seems to point to some additional price reductions before long.

#### VEGETABLE OILS

A great deal of complaint is heard by consumers of vegetable oils that while their prices of finished products have been materially reduced the public is still being forced by the retailer to pay high prices, thereby keeping consumption at a low figure and accentuating the stagnation of the trade. Trading in this line is inactive, prices being largely nominal. On the local market *linseed oil* is off to 91c. per gal. in sellers' tanks f.o.b. the city and to \$1.17 in single barrels from jobbers' stocks. Even these prices induce but little buying. Reports of frost in Argentina and fluctuating prices on flaxseed in Minneapolis and Duluth have failed to give any color to the market. *Cottonseed oil* continues to drop, planters' "strikes" to the contrary not supporting prices. Most recent offers are for crude in cars at the works, 7½c. per lb., and for prime summer yellow in sellers' tanks Chicago, 9½c. Crude *corn oil* is offered at 9c. in tanks here, and *red oil* is nominally 10½c. in car lots, with no buyers.

#### NAVAL STORES

Naval stores are as quiet as other lines, but prices remain fairly steady. In barrels, out of stock in small lots, *turpentine* brings \$1.29 per gal. The end of the season is approaching in the South and industrial demand is keeping up, so that the future trend should be either firm or upward. *Rosin* is quoted at \$13.20 for W.W. and W.G., and only 15c. less for inferior grades. Current fluctuations in foreign exchange cause the export demand of the future to be questionable and this, in turn, is inducing caution on the part of domestic purchasers.

#### The St. Louis Market

St. Louis, Mo., Nov. 12, 1920.

Compared with the enormous activity of the war years present demand may be considered at a low ebb, but heavy chemical producers do not express themselves pessimistically. They state that the volume of business is satisfactory, considering general business conditions, and that a large part of their production for the coming year is on contract, with many other contracts not yet up for renewal. Shipments on contracts have fallen off very little, but spot business is rather dull. Contract prices remain higher than those of last year, but are below the market prevailing several months ago.

Demand for 66 deg. *sulphuric acid* remains fairly steady, but prices have declined for bulk lots, going down to \$22 per ton from \$24. The price in carboys remains at 1½c. per lb., carload lots. The demand from the oil refineries is becoming stronger and producers believe it will continue that way as long as the reserve oil stocks of the country

continue to decline. The 98 per cent *sulphuric acid* market is quiet, and is quoted at \$25 per ton f.o.b. works. The 60 deg. acid is holding firmly at \$16.50 per ton, or 1½c. per lb. in carboys. *Oleum* is firm at \$28.50 per ton.

Stocks of *muriatic acid* are smaller, although demand remains slow. Present price is 1½@2c. per lb. in carboys, against 2@2½c. two weeks ago. In bulk it remains at \$25 per ton.

There is a steady demand for *sodium bisulphate* (niter cake) and on this item prices have advanced. It is quoted now at \$7@8 per ton, as against \$5@6 two weeks ago.

*Nitric acid* demand is fairly strong and prices are steady. Deliveries are normal. Quotations are \$7 per 100 lb. for the 36 deg. test and \$10 per 100 lb. for the 42 deg. test. Standard mixed acid is held nominally at 1½c. per lb. for the sulphuric content and 11½c. per lb. for unit of nitric, with fairly good inquiry.

*Zinc chloride* shows activity, the contract price having advanced to \$4.50 per 100 lb., against \$4 two weeks ago. Demand for U. S. Government supplies of *phenol* is quiet with prices at 12c. per lb. in lots of 15 tons or more.

#### The Iron and Steel Market

Pittsburgh, Nov. 12, 1920.

Production of steel ingots in October was at the rate of about 42,950,000 gross tons per annum, the highest rate shown for any month since December, 1918, with the exception of February and March of this year. The increase over the rate in both September and August, however, was only one-half of 1 per cent. During the month there was a more or less steady decrease in the rate of production, and this decrease has continued, so that the rate today is much below the average of October. Furthermore, production was aligned differently, in October, among producers. Some independent producers curtailed output very materially, while some may have increased their output, and the Steel Corporation, plentifully supplied with orders, certainly did so. The October rate of production is not likely to be equaled until the iron and steel industry has completed its readjustment.

The Steel Corporation's unfilled obligations decreased by 537,952 tons in October, this comparing with decreases of 430,234 tons in September and 313,430 tons in August, while in the fourteen preceding months there had been increases of various amounts.

The October decrease in unfilled obligations was equal to 39 per cent of rated capacity, while shipments may be estimated at about 87 per cent of capacity, which would indicate 48 per cent of capacity for the net bookings, the total bookings minus the cancellations, for even the Steel Corporation, with prices much below those of the independents has had some cancellations. Net bookings at 48 per cent of capacity in October compare with bookings of 53 per cent in September, 57 per cent in August and 85 per cent in July, similarly computed. This decrease in bookings is plainly much less than the decrease in market demand for steel products, and the divergence is readily explained. Ever since the independent prices soared above those of the Steel Corporation the corporation has been offered much more business than it accepted. Of late, in changed circumstances, the corporation has been in position to accept a larger proportion of the business offered, and thus its bookings have not decreased as rapidly as the sum total of market demand has decreased. The independents have been getting the overflow, and the overflow has decreased in correspondingly exaggerated ratio.

#### STEEL PRICES

In one sense the finished steel market is yielding rather rapidly, for there are price declines when the volume of tonnage that can be secured by cutting prices is quite limited. In another sense it is yielding quite slowly, for when everyone is convinced that independent prices are going to settle at least as far as down to the Steel Corporation level one might expect prices to decline at once and be done with the operation. The explanation, of course, is that steel mills with a considerable volume of contract



business on books are indisposed to cut prices when to do so would be to encourage cancellation of the business they already have.

The Steel Corporation prices are of course unaltered. In the independent market black sheets are down a quarter cent in the week to 6c., galvanized being correspondingly 7.50@7.75c. Bars, shapes and plates remain generally at 3c., with more likelihood of the price being cut for a desirable order. All effort to obtain \$8.50 for tin plate has been abandoned, and odd lots arising in stock are offered at \$7.50.

#### PIG IRON

A week ago foundry pig iron was quotable nominally at \$45 valley. Quotations have since been made by furnaces at \$40, without any important sales being made, and the market is quotable at \$40. Bessemer remains quotable at \$42 and basic at \$38.50 valley. Declines from the top points reached in August now amount to \$10 in foundry and basic and \$6.50 in bessemer. Part of the declines may be described as practically voluntary reductions on the part of furnaces. Now there is a new attitude. The furnaces see no occasion to make further reductions except when offered suitable inducements by way of actual orders. They point out that the reductions are really large, yet almost no orders have resulted and it is time for consumers to offer inducements. No effort is made to deny that further reductions must come, but there is evidently plenty of time left. Where the market will eventually turn no one ventures to predict. A price of \$28.50 for basic iron would probably be considered quite low in most quarters, but if \$28.50 were to be the eventual turning point, then in declining from \$48.50 to \$38.50 half the total decline has already occurred, and the furnaces consider that quite a concession, particularly for a period of less than two months.

#### FUTURE OF STEEL PRICES

It is curious that it is commonly if not universally predicted that the independent steel market will decline to the Steel Corporation level, the market then being stabilized, and practically no thought is given to the important point that if the independents are forced to go down to the corporation level it will only be in such circumstances that they will be forced to compete for business, in which case it is a fair presumption that they will cut the Steel Corporation prices. No independent shows a disposition voluntarily to drop to the corporation level. Any decline will be forced by lean order books. Hence while the common prediction is that the independents will get down to the corporation level a more precise prediction would be that the Steel Corporation prices are the only prices at which the independents are unlikely to sell.

In some circles the possibility is now being referred to of the Steel Corporation itself reducing its prices somewhat. The corporation's policy is that of seeking moderate profits only, and the profits have no doubt been eminently satisfactory, particularly in view of the very conservative accounting methods the corporation unquestionably follows. Costs may come down somewhat, although only so recently as Aug. 26 the freight advances effected a large increase in costs. Possibly the corporation may readjust prices on the basis of relative costs, reducing some prices and leaving others alone.

There is a large latent demand on the part of the railroads which are now operated under legislation that seems to insure a fair return, making railroad investment safe if not especially profitable, while there is such control that makes it certain large railroad purchases will not be made unless it is clear the prices are right. If a resumption of buying of steel products is to be led by the railroads the price readjustment may have to be more drastic than would otherwise be the case. It is possible also that there is considerable latent buying by way of investment construction, in cases in which the prospective investors have definite ideas as to the prices they will be charged, and their attitude may have to be taken into account when the steel market finds its eventual turning point in the matter of prices.

### General Chemicals

#### CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride.....	lb.		\$0.65 - \$0.75
Acetone.....	lb.	\$0.15 - \$0.16	.16 - .17
Acid, acetic, 28 per cent.....	100 lbs.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent.....	100 lbs.	7.50 - 8.00	8.50 - 9.50
Acetic, glacial, 99 1/2 per cent, carboy.....	100 lbs.	11.50 - 12.00	12.50 -
Boric, crystals.....	lb.	.15 - .16	.16 - .19
Boric, powder.....	lb.	.15 - .16	.17 - .20
Citric.....	lb.		.54 - .55
Hydrochloric (nominal).....	100 lb.	1.85 - 2.25	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal).....	lb.	.15 - .16	.16 - .18
Lactic, 44 per cent tech.....	lb.	.10 - .11	.12 - .16
Lactic, 22 per cent tech.....	lb.	.04 - .05	.06 - .07
Molybdic, C. P.....	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	lb.		
Nitric, 40 deg.....	lb.	.07 - .07	.08 - .08
Nitric, 42 deg.....	lb.	.07 - .08	.08 - .09
Oxalic, crystals.....	lb.	.23 - .24	.24 - .25
Phosphoric, Ortho, 50 per cent solution.....	lb.	.19 - .20	.21 - .22
Picric.....	lb.	.28 - .35	.40 - .50
Pyrazolic, resublimed.....	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars.....	ton	11.00 - 12.00	
Sulphuric, 60 deg., drums.....	ton		
Sulphuric, 66 deg., tank cars.....	ton	18.00 - 19.00	
Sulphuric, 66 deg., drums.....	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums.....	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....	ton	32.00 - 35.00	40.00 -
Tannic, U. S. P.....	lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech.).....	lb.	.60 - .70	.80 - .90
Tartaric, crystals.....	lb.		.49 - .52
Tungstic, per lb. of WO.....	lb.		1.20 - 1.40
Alcohol, Ethyl (nominal).....	gal.	5.75 - 6.25	
Alcohol, Methyl (see methanol).....	gal.		
Alcohol, denatured, 188 proof (nominal).....	gal.		1.12 - 1.15
Alcohol, denatured, 190 proof (nominal).....	gal.		1.05 - 1.10
Alum, ammonia lump.....	lb.	.04 - .04	.05 - .05
Alum, potash lump.....	lb.	.05 - .06	.06 - .07
Alum, chrome lump.....	lb.	.14 - .15	.16 - .17
Aluminum sulphate, commercial.....	lb.	.03 - .03	.04 - .04
Aluminum sulphate, iron free.....	lb.	.04 - .05	.05 - .06
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	.08 - .09	.09 - .10
Ammonia, anhydrous, cylinders (100-150 lb).....	lb.	.33 - .35	.36 - .38
Ammonium carbonate, powder.....	lb.	.14 - .15	.16 - .16
Ammonium chloride, granular (white sal-ammoniac) (nominal).....	lb.	.13 - .13	.14 - .14
Ammonium chloride, granular (gray sal-ammoniac).....	lb.	.12 - .13	.13 - .14
Ammonium nitrate.....	lb.		.11 - .14
Ammonium sulphate (f.o.b. New Orleans).....	lb.	.05 - .05	.06 - .06
Amylacetate.....	gal.		4.50 - 5.00
Amylacetate, tech.....	gal.		4.00 - 4.20
Arsenic, oxide, lumps (white arsenic).....	lb.	.13 - .13	.14 - .14
Arsenic, sulphide, powdered (red arsenic).....	lb.	.18 - .19	.19 - .20
Barium chloride.....	ton	90.00 - 95.00	100.00 - 105.00
Barium dioxide (peroxide).....	lb.	.24 - .25	.26 - .27
Barium nitrate.....	lb.	.12 - .12	.13 - .13
Barium sulphate (precip.) (blanc fixe).....	lb.	.04 - .05	.05 - .06
Bleaching powder (see calcium hypochlorite).....	lb.		
Blue vitriol (see copper sulphate).....	lb.		
Borax (see sodium borate).....	lb.		
Brimstone (see sulphur, roll).....	lb.		
Bromine.....	lb.	.70 - .80	.85 - .90
Calcium acetate.....	100 lbs.	3.50 - 3.55	
Calcium carbide.....	lb.	.05 - .06	.06 - .06
Calcium chloride, fused, lump.....	ton	30.00 - 32.00	33.00 - 35.00
Calcium chloride, granulated.....	lb.	.02 - .02	.03 - .03
Calcium hypochlorite (bleaching powder).....	lb.	.05 - .05	.06 - .06
Calcium peroxide.....	lb.		1.50 - 1.70
Calcium phosphate, monobasic.....	lb.		.75 - .80
Calcium sulphate, pure.....	lb.		.25 - .30
Camphor.....	lb.		1.10 - 1.15
Carbon bisulphide.....	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums.....	lb.	.13 - .14	.16 - .17
Carbonyl chloride (phosgene).....	lb.		1.25 - 1.50
Caustic potash (see potassium hydroxide).....	lb.		
Caustic soda (see sodium hydroxide).....	lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	.09 - .09	.10 - .10
Chloroform.....	lb.	.40 - .43	.44 - .47
Cobalt oxide.....	lb.		3.75 - 4.00
Copperas (see iron sulphate).....	lb.		
Copper carbonate, green precipitate.....	lb.	.27 - .28	.29 - .31
Copper cyanide.....	lb.		.65 - .70
Copper sulphate, crystals.....	lb.	.07 - .08	.08 - .09
Cream of tartar (see potassium bitartrate).....	lb.		
Ensom salt (see magnesium sulphate).....	lb.		
Ethyl Acetate Com. 85%.....	gal.		1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....	lb.		
Formaldehyde, 40 per cent (nominal).....	gal.	.25 - .26	.27 - .28
Fusel oil, ref.....	gal.		4.25 - 4.50
Fusel oil, crude (nominal).....	gal.		3.25 - 3.50
Glauber's salt (see sodium sulphate).....	lb.		
Glycerine, C. P. drums extra.....	lb.		.27 - .28
Iodine, resublimed.....	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red.....	lb.		.15 - .25
Iron sulphate (copperas).....	100 lbs.	2.25 - 2.50	2.75 - 3.00
Lead acetate, normal.....	lb.		.13 - .16
Lead arsenate (paste).....	lb.	.13 - .14	.14 - .15
Lead nitrate, crystals.....	lb.		.90 - 1.00
Litharge.....	lb.	.12 - .12	.13 - .13
Lithium carbonate.....	lb.		1.50 -
Magnesium carbonate, technical.....	lb.	.11 - .12	.12 - .13
Magnesium sulphate, U. S. P.....	100 lb.	3.00 - 3.25	
Magnesium sulphate, commercial.....	100 lb.		3.50 - 3.60
Methanol, 95%.....	gal.		2.70 - 2.75
Methanol, pure.....	gal.		2.90 - 3.00
Nickel salt, double.....	lb.		.14 - .14
Nickel salt, single.....	lb.		.16 - .16
Phosgene (see carbonyl chloride).....	lb.		
Phosphorus, red.....	lb.	.50 - .55	.60 - .65
Phosphorus, yellow.....	lb.		.35 - .37
Potassium bichromate.....	lb.	.22 - .23	.23 - .24



	Carlots	Less Carlots
Potassium bitartrate (cream of tartar).....lb.	\$0.45 - \$0.47	\$0.48 - \$0.49
Potassium bromide, granular.....lb.	45 - 50	45 - 50
Potassium carbonate, U. S. P.....lb.	50 - 55	56 - 60
Potassium carbonate, crude.....lb.	17 - 18	18 - 19
Potassium chlorate, crystals.....lb.	18 - 18 1/2	19 - 20
Potassium hydroxide (caustic potash).....lb.	16 1/2 - 16 1/2	17 - 17 1/2
Potassium iodide.....lb.	3.20 - 3.30	3.20 - 3.30
Potassium nitrate.....lb.	14 - 16	16 1/2 - 17
Potassium permanganate.....lb.	63 - 68	70 - 75
Potassium prussiate, red.....lb.	73 - 75	78 - 80
Potassium prussiate, yellow.....lb.	36 - 37	37 1/2 - 38 1/2
Potassium sulphate (powdered).....ton	\$240.00 - \$255.00	
Rochelle salts (see sodium potas. tartrate)		
Salammoniac (see ammonium chloride)		
Salt soda (see sodium carbonate)		
Salt cake.....ton	52.00 - 55.00	
Silver cyanide (nominal).....oz.	1.25 - 1.25	
Silver nitrate (nominal).....oz.	60 - 62	
Soda ash, light.....100 lb.	2.15 - 2.25	2.30 - 2.50
Soda ash, dense.....100 lb.	2.50 - 2.75	3.00 - 3.25
Sodium acetate.....lb.	08 1/2 - 09	09 1/2 - 09 1/2
Sodium bicarbonate.....100 lb.	2.90 - 3.00	3.25 - 3.50
Sodium bichromate.....lb.	10 1/2 - 10 1/2	11 - 11 1/2
Sodium bisulphate (nitre cake).....ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphate powdered, U. S. P.....lb.	06 1/2 - 07 1/2	08 - 09
Sodium borate (borax).....lb.	09 - 10	11 - 12
Sodium carbonate (sal soda).....100 lb.	2.00 - 2.10	2.15 - 2.25
Sodium chlorate.....lb.	14 1/2 - 15	15 1/2 - 16 1/2
Sodium cyanide, 96-98 per cent.....lb.	28 - 30	31 - 32
Sodium fluoride.....lb.	20 - 20 1/2	21 - 22
Sodium hydroxide (caustic soda).....100 lb.	4.10 - 4.30	4.60 - 4.75
Sodium hyposulphite.....lb.		04 - 04 1/2
Sodium molybdate.....lb.	2.50 - 3.00	3.25 - 3.50
Sodium nitrate.....100 lb.	3.00 - 3.00	3.25 - 3.50
Sodium nitrite.....lb.	07 1/2 - 08	08 1/2 - 08 1/2
Sodium peroxide, powdered.....lb.	50 - 51	51 1/2 - 52
Sodium phosphate, dibasic.....lb.	03 1/2 - 04 1/2	04 - 05
Sodium potassium tartrate (Rochelle salts) lb.		37 - 38
Sodium prussiate, yellow.....lb.	20 1/2 - 21	21 1/2 - 22
Sodium silicate, solution (40 deg).....lb.	01 - 01 1/2	02 - 02 1/2
Sodium silicate, solution (60 deg).....lb.	02 1/2 - 03	04 - 05
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	2.15 - 2.50	2.60 - 2.75
Sodium sulphide, crystal, 60-62 percent (cone) lb.	07 - 07 1/2	07 1/2 - 08
Sodium sulphite, crystals.....lb.	04 - 0 4 1/2	04 1/2 - 05
Strontium nitrate, powdered.....lb.	20 - 20 1/2	21 - 22
Sulphur chloride red.....lb.	08 - 09	10 - 10 1/2
Sulphur, crude.....ton	16.00 - 20.00	
Sulphur dioxide, liquid, cylinders.....lb.	09 - 10	10 - 12
Sulphur (sublimed), flour.....100 lb.		3.70 - 4.35
Sulphur, roll (brimstone).....100 lb.		3.40 - 3.90
Tin bichloride, 50 per cent.....lb.	18 - 19	
Tin oxide.....lb.		50 - 51
Zinc carbonate, precipitate.....lb.	16 - 18	19 - 20
Zinc chloride, gran.....lb.	12 - 13	13 1/2 - 14
Zinc cyanide.....lb.	45 - 49	50 - 60
Zinc dust.....lb.	12 - 13	13 - 14
Zinc oxide, XX.....lb.	11 - 11 1/2	
Zinc sulphate.....lb.	03 1/2 - 03 1/2	04 - 06

### Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....lb.	\$1.10 - \$1.15
Alpha-naphthol, refined.....lb.	1.45 - 1.50
Alpha-naphthylamine.....lb.	48 - 50
Aniline oil, drums extra.....lb.	27 - 30
Aniline salts.....lb.	32 - 33
Anthracene, 80% in drums (100 lb.).....lb.	90 - 1.00
Benzaldehyde (f. c.).....lb.	2.00 - 2.10
Benzidine, base.....lb.	1.15 - 1.20
Benzidine sulphate.....lb.	1.10 - 1.15
Benzoic acid, U. S. P.....lb.	80 - 85
Benzoate of soda, U. S. P.....lb.	80 - 90
Benzene, pure, water-white, in drums (100 gal.).....gal.	35 - 40
Benzene, 90% in drums (100 gal.).....gal.	33 - 38 1/2
Benzyl chloride, 95-97%, refined.....lb.	35 - 40
Benzyl chloride, tech.....lb.	25 - 35
Beta-naphthol benzoate (nominal).....lb.	3.50 - 4.00
Beta-naphthol, sublimed (nominal).....lb.	90 - 95
Beta-naphthol, tech (nominal).....lb.	46 - 49
Beta-naphthylamine, sublimed.....lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.).....lb.	18 - 19
Ortho-cresol, in drums (100 lb.).....lb.	23 - 25
Cresylic acid, 97-99%, straw color, in drums.....gal.	1.10 - 1.15
Cresylic acid, 95-97%, dark, in drums.....gal.	1.05 - 1.10
Cresylic acid, 50%, first quality, drums.....gal.	65 - 75
Dichlorobenzene.....lb.	07 - 10
Diethylaniline.....lb.	1.45 - 1.50
Dimethylaniline.....lb.	90 - 95
Dinitrobenzene.....lb.	30 - 37
Dinitrochlorobenzene.....lb.	27 - 32
Dinitronaphthalene.....lb.	42 - 45
Dinitrophenol.....lb.	40 - 45
Dinitrotoluene.....lb.	38 - 40
Dip oil, 25% tar acids, car lots, in drums.....gal.	38 - 40
Diphenylamine (nominal).....lb.	80 - 85
H-acid (nominal).....lb.	1.65 - 1.70
Meta-phenylenediamine.....lb.	1.25 - 1.30
Monochlorobenzene.....lb.	18 - 20
Monocethylaniline.....lb.	1.75 - 2.25
Naphthalene crushed, in bbls. (250 lb.).....lb.	08 - 09
Naphthalene, flake.....lb.	08 - 09
Naphthalene, balls.....lb.	09 - 09 1/2
Naphthionic acid, crude.....lb.	70 - 75
Nitrobenzene.....lb.	12 - 15
Nitro-naphthalene.....lb.	40 - 50
Nitro-toluene.....lb.	18 - 25
Ortho-amidophenol.....lb.	3.20 - 3.75
Ortho-dichlorobenzene.....lb.	15 - 20
Ortho-nitro-phenol.....lb.	75 - 80
Ortho-nitro-toluene.....lb.	25 - 40
Ortho-toluidine.....lb.	32 - 35
Para-amidophenol, base.....lb.	2.50 - 3.00
Para-amidophenol, HCl.....lb.	2.50 - 3.00
Para-dichlorobenzene.....lb.	10 - 15
Paranitroaniline.....lb.	1.15 - 1.20

Para-nitrotoluene.....lb.	1.25 - 1.40
Para-phenylenediamine.....lb.	2.50 - 2.65
Para-toluidine.....lb.	1.85 - 2.00
Phthalic anhydride.....lb.	60 - 70
Phenol, U. S. P., drums (dest.), (240 lb.).....lb.	12 - 14
Pyridine.....gal.	2.00 - 3.50
Resorcinol, technical.....lb.	2.90 - 3.00
Resorcinol, pure.....lb.	3.75 - 4.15
Salicylic acid, tech., in bbls. (110 lb.).....lb.	35 - 38
Salicylic acid, U. S. P.....lb.	40 - 45
Salol.....lb.	85 - 95
Solvent naphtha, water-white, in drums, 100 gal.....gal.	30 - 35 1/2
Solvent naphtha, crude, heavy, in drums, 100 gal.....gal.	19 - 22
Sulphanilic acid, crude.....lb.	32 - 35
Tolidine.....lb.	1.75 - 1.80
Toluidine, mixed.....lb.	45 - 55
Toluene, in tank cars.....gal.	35 - 40
Toluene, in drums.....gal.	41 - 42
Xylidines, drums, 100 gal.....lb.	50 - 65
Xylene, pure, in drums.....gal.	45 - 47
Xylene, pure, in tank cars.....gal.	45 - 47
Xylene, commercial, in drums, 100 gal.....gal.	37 - 38
Xylene, commercial, in tank cars.....gal.	30 - 35

### Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....lb.	\$0.31 - \$0.33
Beeswax, refined, light.....lb.	34 - 37
Beeswax, white pure.....lb.	55 - 60
Carnauba, No. 1 (nominal).....lb.	80 - 90
Carnauba, No. 2, regular (nominal).....lb.	70 - 80
Carnauba, No. 3, North Country.....lb.	25 - 26
Japan.....lb.	19 - 20
Montan, crude.....lb.	12 - 14
Paraffine waxes, crude match wax (white) 105-110 m.p.....lb.	08 - 08 1/2
Paraffine waxes, crude, scale 124-126 m.p.....lb.	08 - 08 1/2
Paraffine waxes, refined, 118-120 m.p.....lb.	09 - 09 1/2
Paraffine waxes, refined, 125 m.p.....lb.	09 - 09 1/2
Paraffine waxes, refined, 128-130 m.p.....lb.	10 - 11
Paraffine waxes, refined, 133-135 m.p.....lb.	13 - 14
Paraffine waxes, refined, 135-137 m.p.....lb.	14 - 15
Stearic acid, single pressed.....lb.	17 - 17 1/2
Stearic acid, double pressed.....lb.	18 - 19
Stearic acid, triple pressed.....lb.	22 - 23

### Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.946.....gal.	\$1.90
Pine oil, pure, dest. dist.....gal.	1.50
Pine tar oil, ref., sp. gr. 1.025-1.035.....gal.	48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....gal.	35
Pine tar oil, double ref., sp. gr. 0.965-0.990.....gal.	75
Pine tar, ref., thin, sp. gr. 1.080-1.060.....gal.	36
Turpentine, crude, sp. gr. 0.900-0.970.....gal.	1.25
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990.....gal.	35
Pinewood creosote, ref.....gal.	52

### Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin H-D, bbl.....280 lb.	\$12.75
Rosin E-L.....280 lb.	12.75
Rosin K-N.....280 lb.	12.75
Rosin W. G. W. W.....280 lb.	13.00
Wood rosin, bbl.....280 lb.	11.00
Spirits of turpentine.....gal.	1.20
Wood turpentine, steam dist.....gal.	1.16
Wood turpentine, dest. dist.....gal.	1.10
Pine tar pitch, bbl.....200 lb.	8.50
Tar, kiln burned, bbl (500 lb.).....bbl.	15.00
Retort tar, bbl.....500 lb.	15.00
Rosin oil, first run.....gal.	70
Rosin oil, second run.....gal.	73
Rosin oil, third run.....gal.	90

### Solvents

73-76 deg., steel bbls. (85 lb.).....gal.	\$0.41
70-72 deg., steel bbls. (85 lb.).....gal.	39
68-70 deg., steel bbls. (85 lb.).....gal.	38
V. M. and P. naphtha, steel bbls. (85 lb.).....gal.	30

### Crude Rubber

Para-Upriver fine (nominal).....lb.	\$0.22 - \$0.23
Upriver coarse (nominal).....lb.	15 - 16
Upriver caucho ball (nominal).....lb.	16 1/2 - 17 1/2
Plantation—First latex crepe.....lb.	19 - 20
Ribbed smoked sheets.....lb.	18
Brown crepe, thin, clean.....lb.	16
Amber crepe No. 1.....lb.	17

### Oils

#### VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.....lb.	\$0.14 - \$0.15
Castor oil, AA, in bbls.....lb.	15 - 16 1/2
China wood oil, in bbls. (f.o.b. Pac. coast).....lb.	13 - 14
Cocanut oil, Ceylon grade, in bbls.....lb.	14 - 14 1/2
Cocanut oil, Cochon grade, in bbls (nominal).....lb.	15 - 16
Cora oil, crude, in bbls.....lb.	11 - 11 1/2
Cottonseed oil, crude (f.o.b. mill).....lb.	08 - 08 1/2
Cottonseed oil, summer yellow.....lb.	11 - 12 1/2
Cottonseed oil, winter yellow.....lb.	13 - 14
Linsed oil, raw, car lots (domestic).....gal.	1.00
Linsed oil, raw, tank cars (domestic).....gal.	95
Linsed oil, boiled, car lots (domestic).....gal.	1.01

Olive oil, commercial.....	gal.	2.75	—	3.00
Palm, Lagos.....	lb.	.10	—	.10
Palm, Niger.....	lb.	.09	—	.09
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.09
Peanut oil, refined, in bbls.....	lb.	.15	—	.15
Rapeseed oil, refined in bbls.....	gal.	1.15	—	1.20
Rapeseed oil, blown, in bbls.....	gal.	1.25	—	1.35
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.11	—	.11
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.08	—	.08

## FISH

Light pressed Menhaden.....	gal.	\$0.65	—	\$0.70
Yellow bleached Menhaden.....	gal.	.67	—	.70
White bleached Menhaden.....	gal.	.72	—	.75
Blown Menhaden.....	gal.	1.05	—	1.10

## Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	\$30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	12.00
Blanc fixe, dry.....	lb.	.05	—	.05
Blanc fixe, pulp.....	net ton	60.00	—	65.00
Casene.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia.....	net ton	9.00	—	12.00
China clay (Kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	30.00
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	20.00
Fuller's earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.11	—	.40
Graphite, higher lubricating grades.....	lb.	.04	—	.50
Pumice stone, imported, lump.....	lb.	.06	—	.06
Pumice stone, domestic, lump.....	lb.	.04	—	.07
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore.....	net ton	10.00	—	10.00
Quartz (acid tower) 1 1/2 in. f.o.b. Baltimore.....	net ton	14.00	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	17.00	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	1.05	—	1.10
Shellac, orange superfine.....	lb.	.90	—	.95
Shellac, A. C. garnet.....	lb.	.85	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Soapstone.....	ton	15.00	—	25.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	60.00	—	70.00
Talc, California Talcum Powder grade.....	ton	20.00	—	45.00

## Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100-110	
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub> .....	net ton	55-60	
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub> , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60-65	
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	
Magnesite brick, 9-in. straight.....	net ton	110	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121	
Magnesite brick, soaps and splits.....	net ton	134	
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	55-60	

## Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.18	—	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.17	—	.18
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	170.00	—	175.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	165.00	—	170.00
Spiegelisen, 18-22% Mn.....	gross ton	75.80	—	80.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferro-silicon, 10-15%.....	gross ton	60.00	—	65.00
Ferro-silicon, 50%.....	gross ton	80.00	—	85.00
Ferro-silicon, 75%.....	gross ton	160.00	—	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	.75	—	.90
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	7.00
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	6.50	—	8.50

## Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe <sub>2</sub> O <sub>3</sub> , up to 20% silica, not more than H <sub>2</sub> O moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr <sub>2</sub> O <sub>3</sub> .....	unit	.70	—	.75
Chrome ore, 50%, Cr <sub>2</sub> O <sub>3</sub> , f.o.b. Atlantic Seaboard.....	unit	.65	—	.75
Coke, foundry, f.o.b. ovens.....	net ton	12.50	—	13.00
Coke, furnace, f.o.b. ovens.....	net ton	11.50	—	12.00
Coke, petroleum, refinery, Atlantic Seaboard.....	net ton	24.00	—	26.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17.50	—	17.50
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	25.00	—	27.50
Ilmenite, 52% TiO <sub>2</sub> , per lb. ore.....	lb.	.011	—	.011
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.60	—	.70
Manganese ore, chemical (MnO <sub>2</sub> ).....	gross ton	70.00	—	80.00
Molybdenite, 85% MoS <sub>2</sub> , per lb. of MoS <sub>2</sub> , N. Y.....	lb.	.65	—	.70
Monazite, per unit of ThO <sub>2</sub> , c.i.f. Atlantic seaport.....	unit	35.00	—	35.00
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.17	—	.17
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO <sub>2</sub> , per lb. ore.....	lb.	.15	—	.15
Tungsten, Scheelite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> (nominal).....	unit	6.00	—	6.00
Tungsten, Wolframite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> , N. Y. C.....	unit	4.50	—	5.00
Uranium Ore (Carnotite) per lb. of U <sub>3</sub> O <sub>8</sub> .....	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U <sub>3</sub> O <sub>8</sub> .....	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V <sub>2</sub> O <sub>5</sub> contained.....	lb.	2.00	—	2.00
Zircon, washed, iron free.....	lb.	.05	—	.05

## Non-Ferrous Metals

New York Markets

Copper, electrolytic.....		Cents per Lb.	14.75
Aluminum, 98 to 99 per cent.....			32.90
Antimony, wholesale lots, Chinese and Japanese.....			6.12 @ 6.25
Nickel, ordinary (ingot).....			43.00
Nickel, electrolytic.....			45.00
Tin, 5-ton lots.....			39.00
Lead, New York, spot.....			7.00-7.25
Lead, E. St. Louis, spot.....			6.80-7.05
Zinc, spot, New York.....			7.00
Zinc, spot, E. St. Louis.....			6.60

## OTHER METALS

Silver (commercial).....	oz.	\$0.911	
Cadmium.....	lb.	1.40 @ 1.50	
Bismuth (500 lb. lots).....	lb.	2.55	
Cobalt.....	lb.	6.00	
Magnesium (f.o.b. Niagara Falls).....	lb.	1.75	
Platinum.....	oz.	85.00 @ 90.00	
Iridium.....	oz.	350.00 @ 400.00	
Palladium.....	oz.	80.00 @ 85.00	
Mercury.....	75 lb.	58.00 @ 60.50	

## FINISHED METAL PRODUCTS

Copper sheets, hot rolled.....		Warehouse Price	Cents per Lb.
Copper bottoms.....			24.50
Copper rods.....			34.00
High brass wire and sheets.....			29.00
High brass rods.....			27.50
Low brass wire and sheets.....			19.00
Low brass rods.....			30.50
Brazed brass tubing.....			24.00
Brazed bronze tubing.....			36.25
Seamless copper tubing.....			41.50
Seamless high brass tubing.....			28.00
			27.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Month Ago	One Year Ago	Chicago
Copper, heavy and crucible.....	12.50	17.00	12.00	13.50
Copper, heavy and wire.....	12.00	16.00	11.75	12.50
Copper, light and bottoms.....	10.00	14.00	10.00	11.00
Lead, heavy.....	5.50	4.75	5.50	6.00
Lead, tea.....	4.50	3.75	3.75	5.00
Brass, heavy.....	7.00	10.50	8.00	12.50
Brass, light.....	5.50	7.50	5.00	6.50
No. 1 yellow brass turnings.....	7.00	10.00	6.00	6.75
Zinc.....	4.50	5.00	3.75	5.00

## Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York		Cleveland		Chicago	
	Current	One Month Ago	Current	One Month Ago	Current	One Month Ago
Structural shapes.....	\$4.15	\$4.47	\$3.44	\$3.37	\$4.08	\$3.47
Soft steel bars.....	4.15	4.62	3.37	3.84	3.98	3.37
Soft steel bar shapes.....	4.15	4.62	3.37	3.84	3.98	3.37
Soft steel bands.....	5.50	6.32	4.07	6.25	4.28	3.67
Plat. s. 1/2 to 1 in. thick.....	4.15	4.67	3.67	3.64	4.28	3.67



# Industrial

Financial, Construction and Manufacturers' News

## Construction and Operation

### Connecticut

**NORWALK**—The St. George Pulp & Paper Co., 6 Smith St., has awarded the contract for the construction of a 1-story, 65x65-ft. addition to its manufacturing plant on Smith St., to A. R. Malkin Co., 3 Mechanic St. Estimated cost, \$15,000.

### District of Columbia

**WASHINGTON**—The General Purchasing Officer of the Panama Canal will receive bids until Nov. 26 for furnishing 6,000 lb. Venetian red, in oil, 300 gal. black locomotive black, grade No. 2, 1,000 lb. Indian red, in oil, 300 lb. green commercial chrome, dry, medium, 10,000 lb. lampblack, in oil, 300 gal. green enamel, 1,000 gal. varnish, damar, white, 3,000 gal. creosote oil, 150 gal. sperm oil, 10,000 gal. linseed oil, 200 gal. muriatic acid, 3,000 lb. lump sulphur, 20,000 lb. lump calcium chloride, 2,000 lb. chloride of lime, 15,000 lb. lye, 100,000 lb. soda ash, 6,000 lb. caustic soda, 3,000 lb. okum.

### Idaho

**IDAHO FALLS**—The Howard Pulp & Paper Co. is having plans prepared for the construction of a news print paper factory including a power plant. Estimated cost, \$4,000,000. T. L. Tomlines, City Bank Bldg., Syracuse, N. Y., engr.

### Illinois

**CHICAGO**—The Alemite Die Castings & Mfg. Co., 314 West Chicago Ave., has awarded the contract for the construction of a 1-story, 150x272-ft. building at 2640 Belmont Ave., to C. B. Johnson & Sons, 111 West Washington St. Estimated cost, \$150,000. Equipment to cost \$200,000 will be installed in same.

**CHICAGO**—The Purity Packing Co., 1620 West 21st St., plans to construct a 2-story addition to its present plant.

**CHICAGO**—Theonett & Co., 2558 Armistage St., plans to build a bottling plant on Belden Ave. between Springfield and Crawford Aves. Estimated cost, \$150,000.

### Iowa

**FORT DODGE**—The Bd. Educ. has awarded the contract for the construction of a 3-story, 190x260-ft. high school to Madsen & Peterson, 646 Builders Exch., Minneapolis, Minn. A chemical laboratory will be installed in same. Estimated cost, \$645,300. Noted Oct. 13.

**SHELLSBURG**—The Bd. Educ. will receive bids about Jan. 15 for the construction of a 3-story, 80x110-ft. grade high school. A chemical laboratory will be installed in same. Estimated cost, \$160,000. A. K. Rife, secy. J. G. Ralston, 709 L. & J. Bldg., Waterloo, archt.

### Kansas

**CANEY**—The city is having plans prepared for the construction of a filtration plant. Black & Veatch, Mutual Bldg., Kansas City, Mo., engr.

### Maryland

**BALTIMORE**—The City Council has awarded the contract for the construction of a 3-story, 76x271x50x241-ft. school at 76 Latrobe Park to the Standard Constr. Co., 1713 Sansome St., Philadelphia, Pa. Estimated cost, \$495,000.

### Massachusetts

**SOMERSET**—The Somerset Stove Fdry. Co. has awarded the contract for the construction of a 1-story, 70x160-ft. foundry to Beattie & Cornell, 33 North Quarry St., Fall River. Estimated cost, \$50,000. Noted Oct. 6.

**SOUTH HADLEY**—Mt. Holyoke College plans to build a science building. Estimated cost, \$500,000. M. E. Woolley, pres.

### Michigan

**RIVER ROUGE**—The Bd. Educ. will soon award the contract for the construction of a 3-story high school on Dearborn Rd. A chemical laboratory will be installed in same. Estimated cost, \$750,000. A. R. Heuer, pres. Van Leyen, Schilling, Keough & Reynolds, 556 Cass Ave., Detroit, archts.

### Minnesota

**ATKIN**—The Bd. Educ. is having plans prepared for the construction of a 2-story, 102x125-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$175,000. Henry S. Swanson, Crosby, archt. and engr.

### New Jersey

**ATLANTIC CITY**—The Bd. Educ. Atlantic and Pacific Aves., plans to build a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$1,000,000.

**RIDGEFIELD**—The Continental Folding Paper Box Co., 122 Washington St., Brooklyn, N. Y., will soon award the contract for the construction of a 2-story, 100x500-ft. factory on Grand Ave. and Hall St. W. B. Wills, Inc., 1181 Myrtle Ave., Brooklyn, N. Y., archt. and engr.

### New York

**POUGHKEEPSIE**—The State Hospital Comm., Capitol, Albany, will receive bids until Dec. 1 for the construction of additions and alterations to the water supply system, including additional filters, etc., at the Hudson River State Hospital here.

### Ohio

**IRONTON**—The Ironton Firebrick Co., Hayward Bldg., plans to build an addition of two 30-ft. round downdraft kilns.

**MARION**—The city is having plans prepared for the construction of a sanitary sewer system and sewage disposal plant. Estimated cost, \$1,000,000.

**YOUNGSTOWN**—The city is in the market for laboratory equipment, etc., at the Municipal Contagious Hospital. Estimated cost, \$60,000.

### Pennsylvania

**GREAT BEND**—The N. H. Parke Leather Co. is having plans prepared for the construction of a 3-story, 75x200-ft. tannery. Estimated cost, \$150,000. Lockwood, Green & Co., 101 Park Ave., New York City, archts and engr.

**PHILADELPHIA**—The Belmont Packing & Rubber Co., 133 North 2nd St., has awarded the contract for the construction of a 2-story, 130x190-ft. addition to its plant on Coral and Wheatstear Sts., to G. Kessler Constr. Co., Drexel Bldg., Philadelphia, Pa. Estimated cost, \$60,000.

### Texas

**DALLAS**—The Baptist Memorial Sanitarium, Junius and College Sts., is having plans prepared for the construction of a 5-story, 100x120-ft. hospital. Chemical laboratories will be installed in same. Estimated cost, \$800,000. C. D. Hill & Co., S. W. Life Bldg., archt.

**DALLAS**—The City and Dallas Co. are having plans prepared by H. M. Greene, archt., North Texas Bldg., for the construction of a hospital to cost about \$450,000. The city voted \$225,000 bonds, county will vote equal amount. Chemical laboratory equipment, including X-ray, etc., will be installed in same. F. W. Wozencraft, mayor.

**LUBBOCK**—The West Texas Sanitarium Association is having plans prepared for the construction of a 4-story sanitarium. A chemical laboratory will be installed in same. Estimated cost, \$110,000. Henry T. Phelps, Gunter Bldg., San Antonio, archt.

**RANGER**—The Ranger Boiler Wks. plans to build a sheet steel and sheet iron manufacturing plant. Estimated cost, \$100,000. L. C. McFall, pres.

### Wisconsin

**CLEAR LAKE**—The Bd. Educ. will receive bids about Dec. 15 for the construction of a 2-story consolidated school. A chemical laboratory will be installed in same. Estimated cost, \$75,000. E. Enderbohn, clk.

**MERRILL**—The Secretary of the Bd. Educ. will receive bids about Dec. 15 for the construction of a 2-story, 140x178-ft. grade school and a 75x120-ft. addition to the high school. A chemical laboratory will be installed in same. Estimated cost, \$260,000. Parkinson & Dockendorf, Linker Bldg., Lacrosse, archts. and engr. Noted Oct. 6.

## Coming Meetings and Events

**AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE** will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

**AMERICAN CERAMIC SOCIETY** will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

**AMERICAN CHEMICAL SOCIETY** will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

**AMERICAN GAS ASSOCIATION** is holding its second annual convention at the Hotel Pennsylvania, New York, Nov. 15 to 20.

**AMERICAN INSTITUTE OF CHEMICAL ENGINEERS** will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

**AMERICAN MINING CONGRESS** is holding its convention in Denver Nov. 15 to 19.

**AMERICAN PETROLEUM INSTITUTE** will hold its annual meeting on Nov. 17, 18 and 19 in Washington, D. C. Headquarters will be at the New Willard Hotel.

**AMERICAN PHYSICAL SOCIETY** will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

**AMERICAN SOCIETY OF MECHANICAL ENGINEERS** 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

**AUTOMOTIVE EQUIPMENT ASSOCIATION** is holding its second annual exposition in the Coliseum, Chicago, Ill., this week. Trucks, automobiles, tractors, motor buses and equipment for airplanes and submarines will be displayed. Meetings are at the Congress Hotel.

**COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA** will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

**FEDERATED AMERICAN ENGINEERING SOCIETIES** will hold its first meeting in Washington, D. C., Nov. 18 and 19. American Engineering Council will hold its organization meeting Nov. 20. Headquarters for both will be at the New Willard Hotel.

**NEW JERSEY CHEMICAL SOCIETY** holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

**PHILADELPHIA SECTION, AMERICAN CHEMICAL SOCIETY**, will hold its regular meeting Nov. 18 at the Engineers' Club, Philadelphia. Ellwood Hendrick will speak on "Relativity and Life."

**TAYLOR SOCIETY** will hold its annual meeting Dec. 2, 3 and 4 in the Engineering Societies Bldg., New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Nov. 19, American Chemical Society; Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry; American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry; American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.